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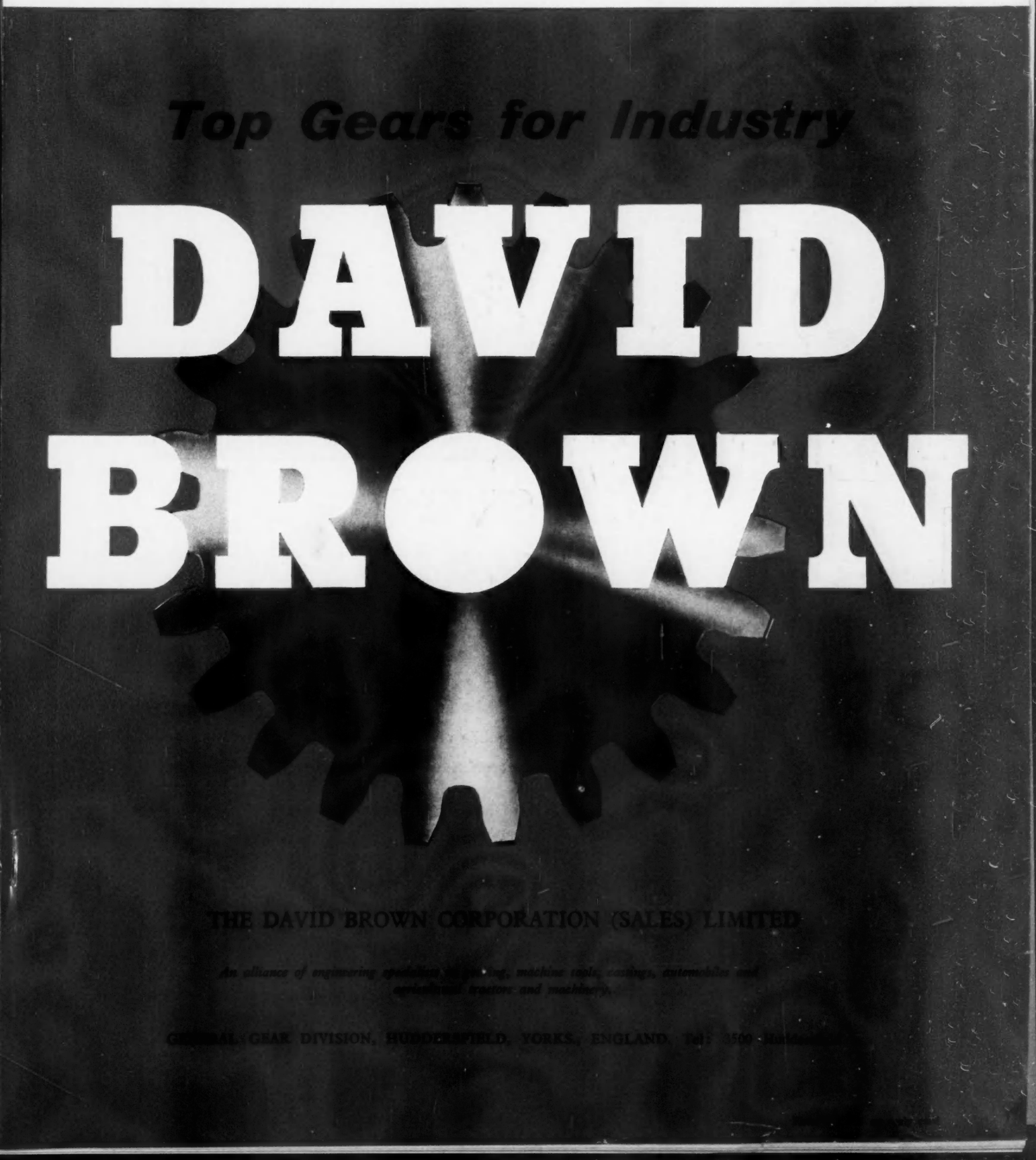
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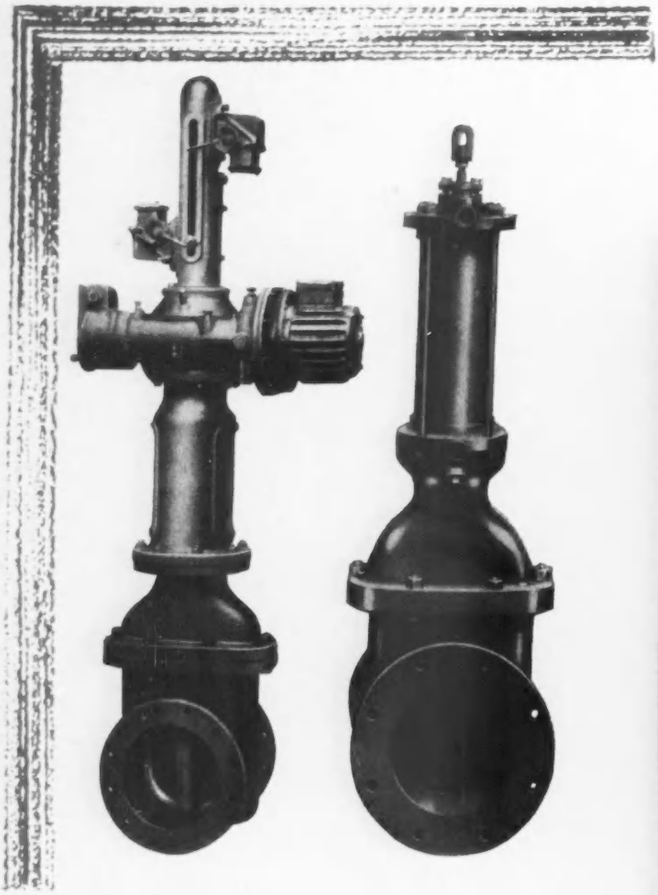

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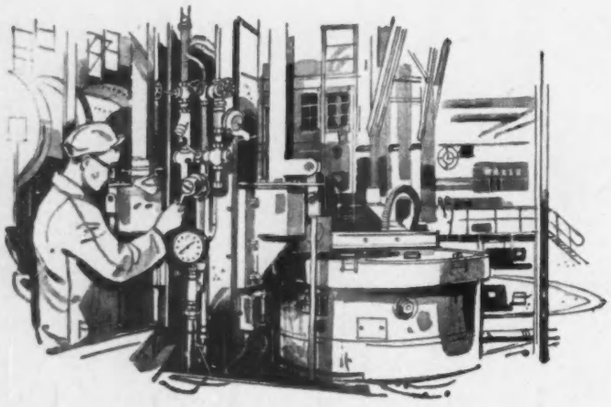

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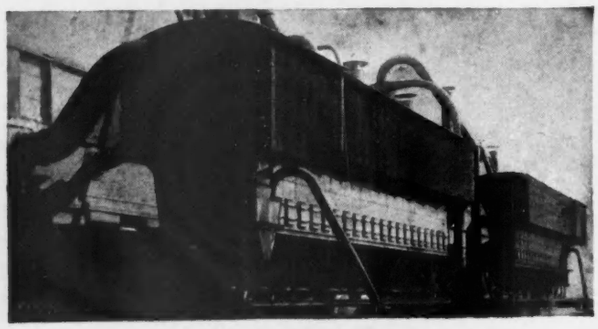

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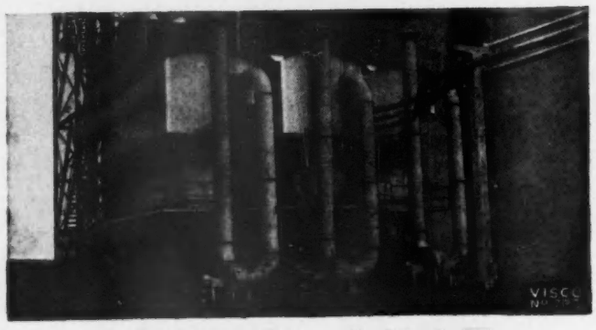

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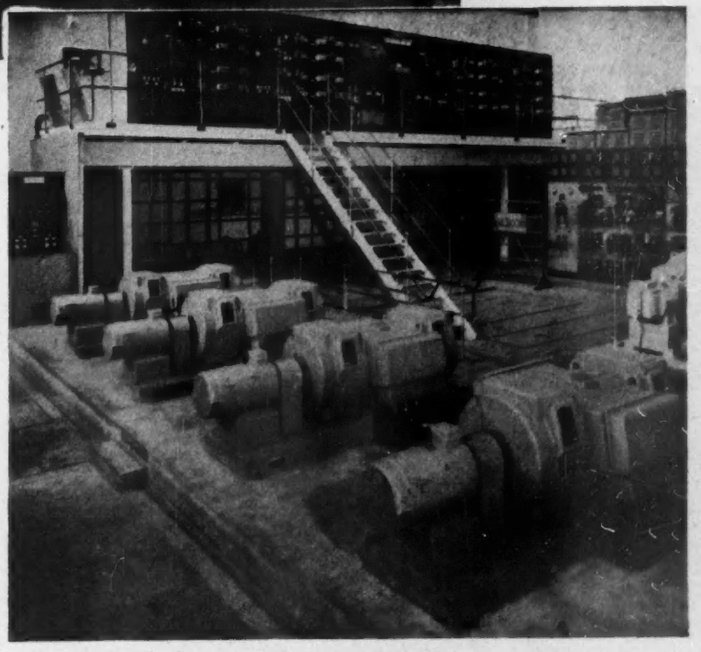

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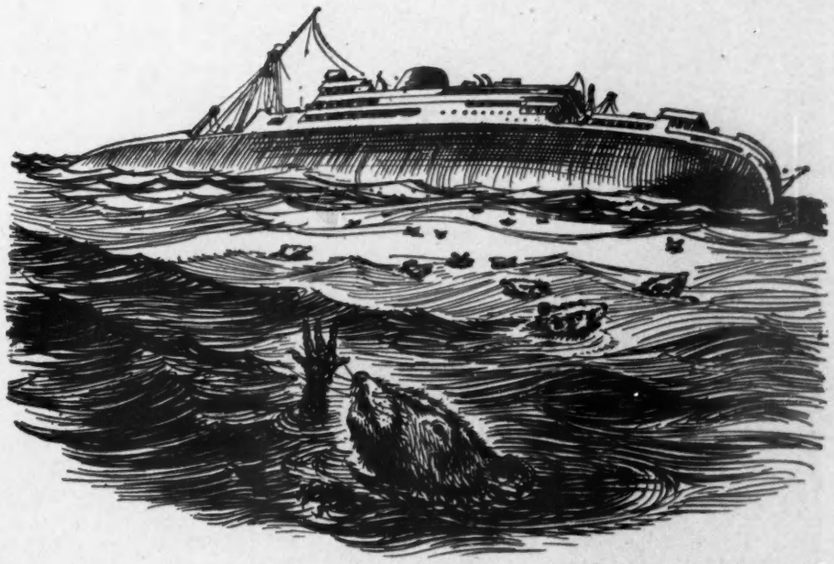

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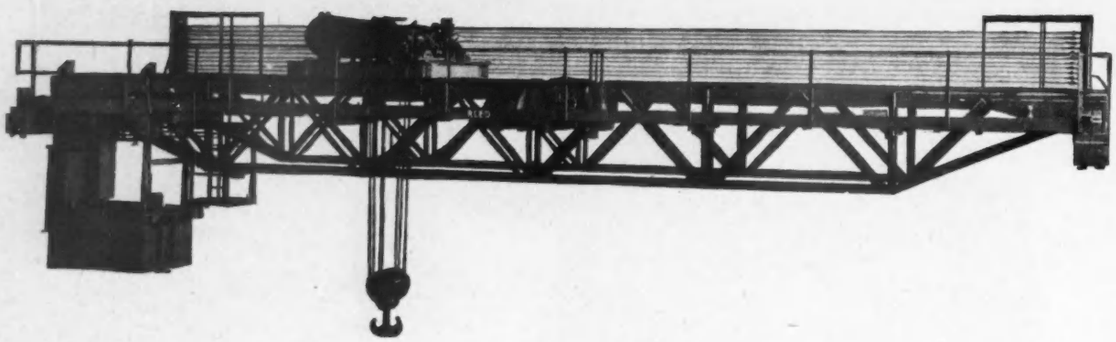

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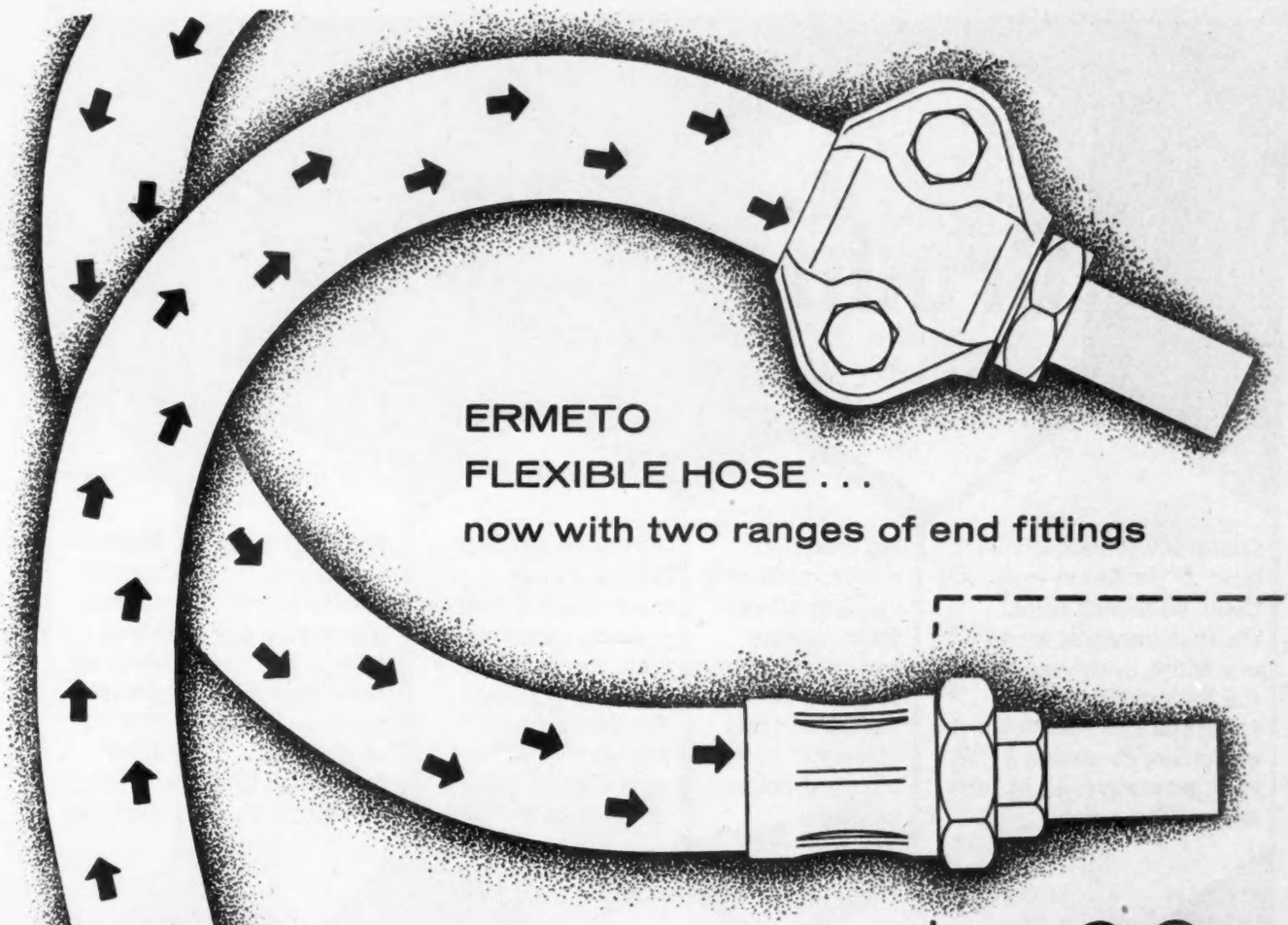

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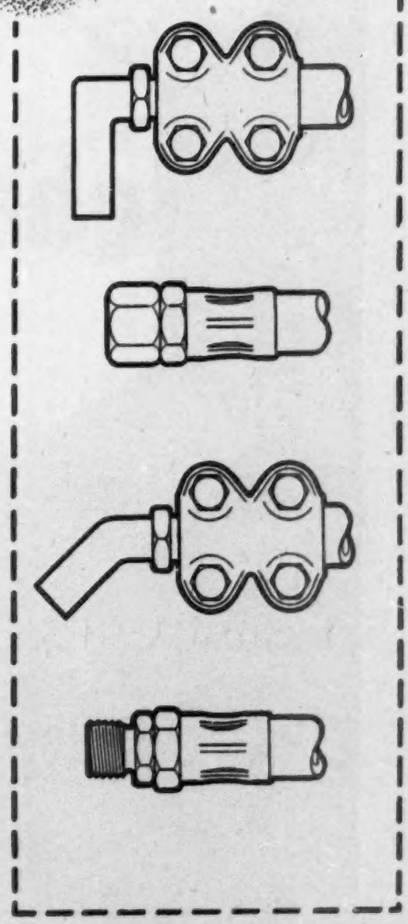

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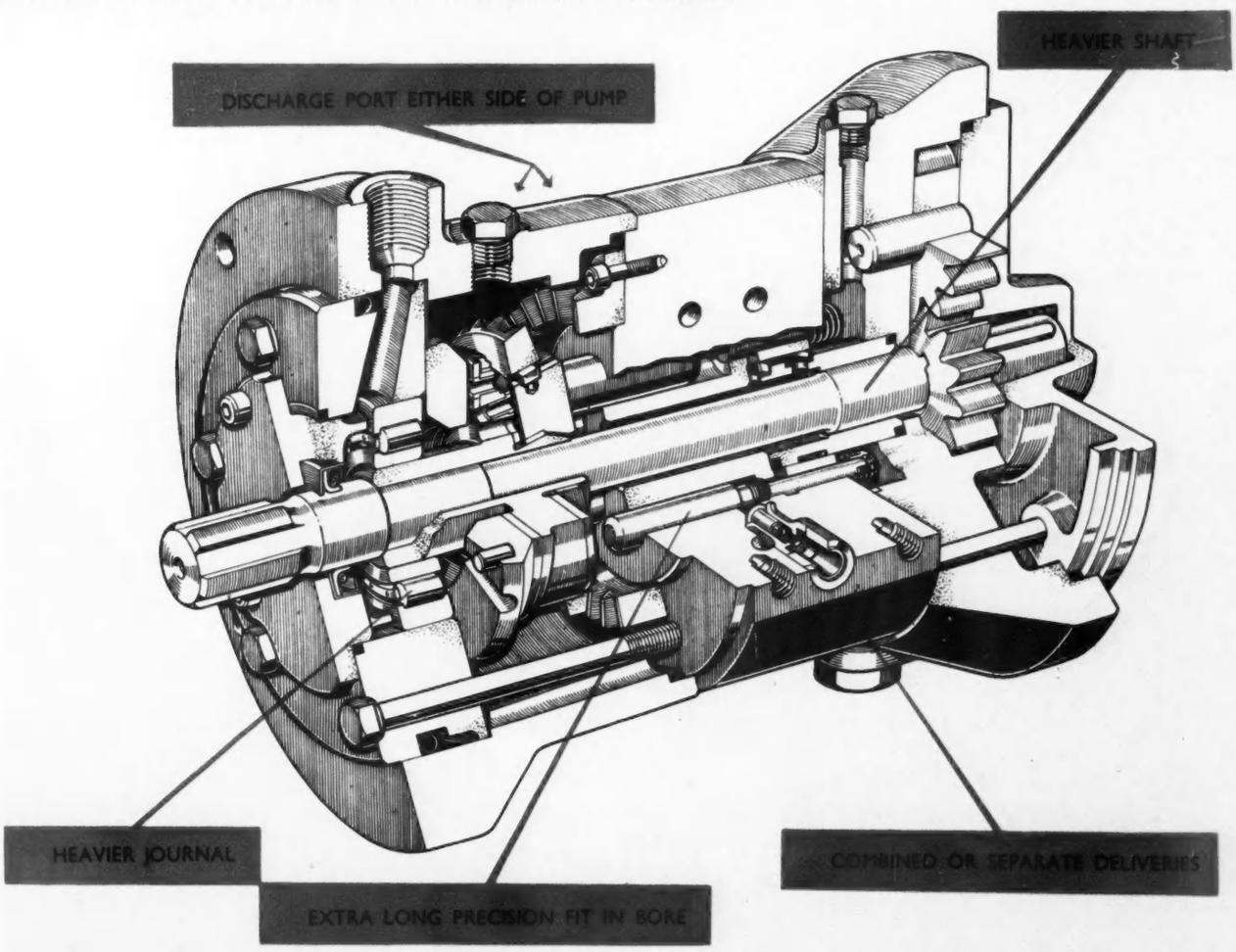
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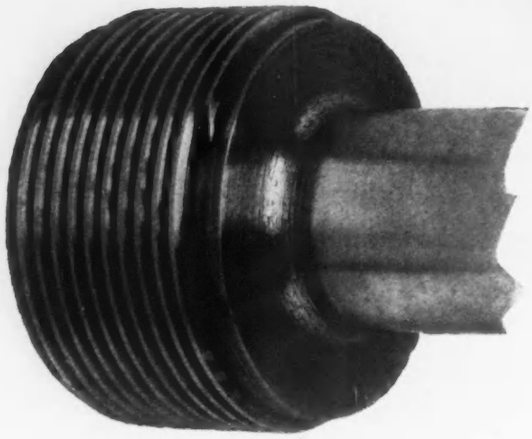

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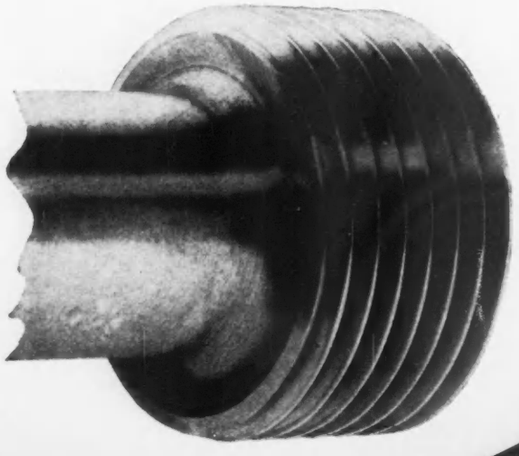

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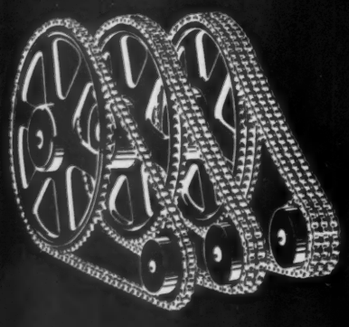

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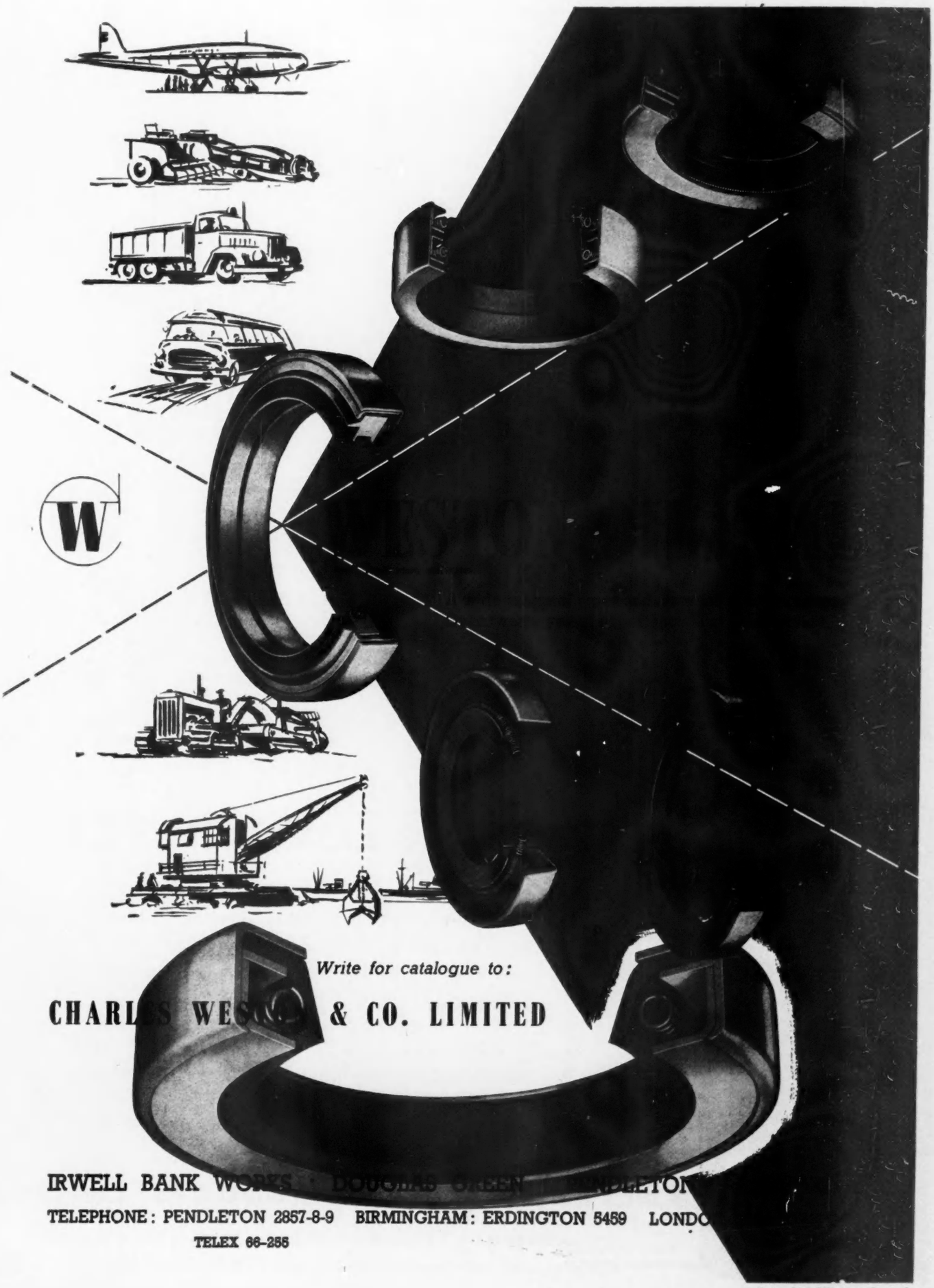

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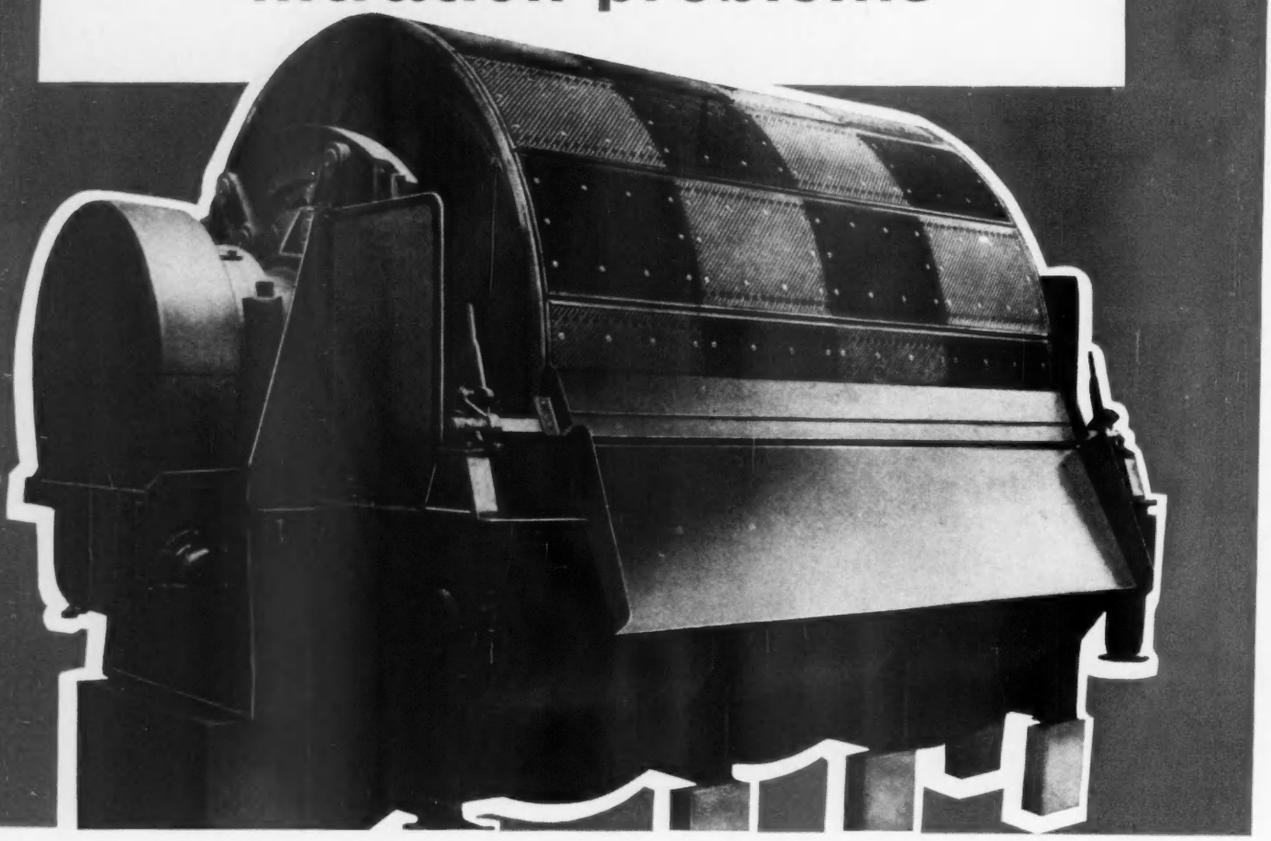

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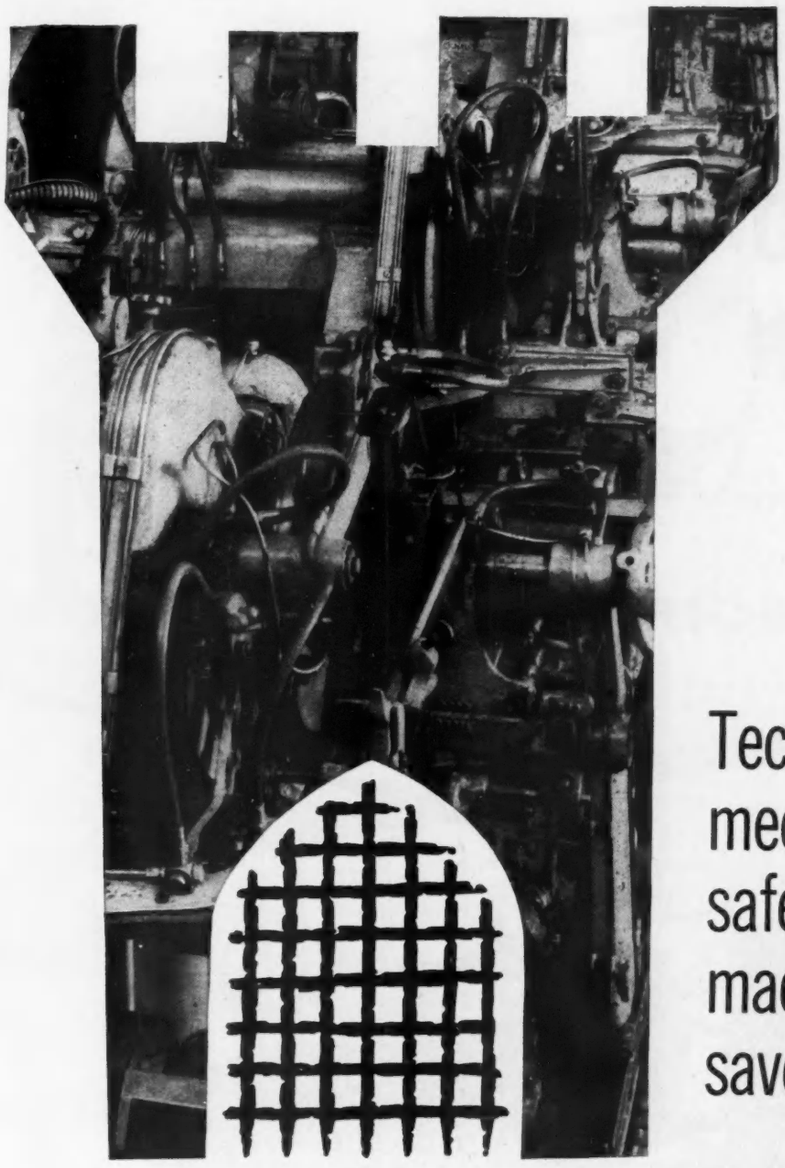

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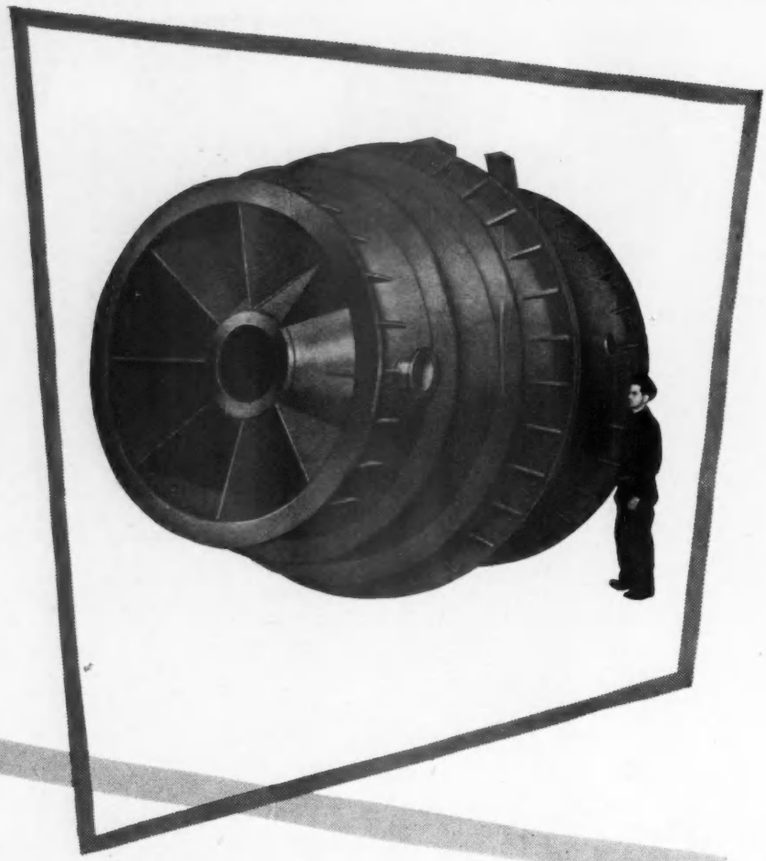

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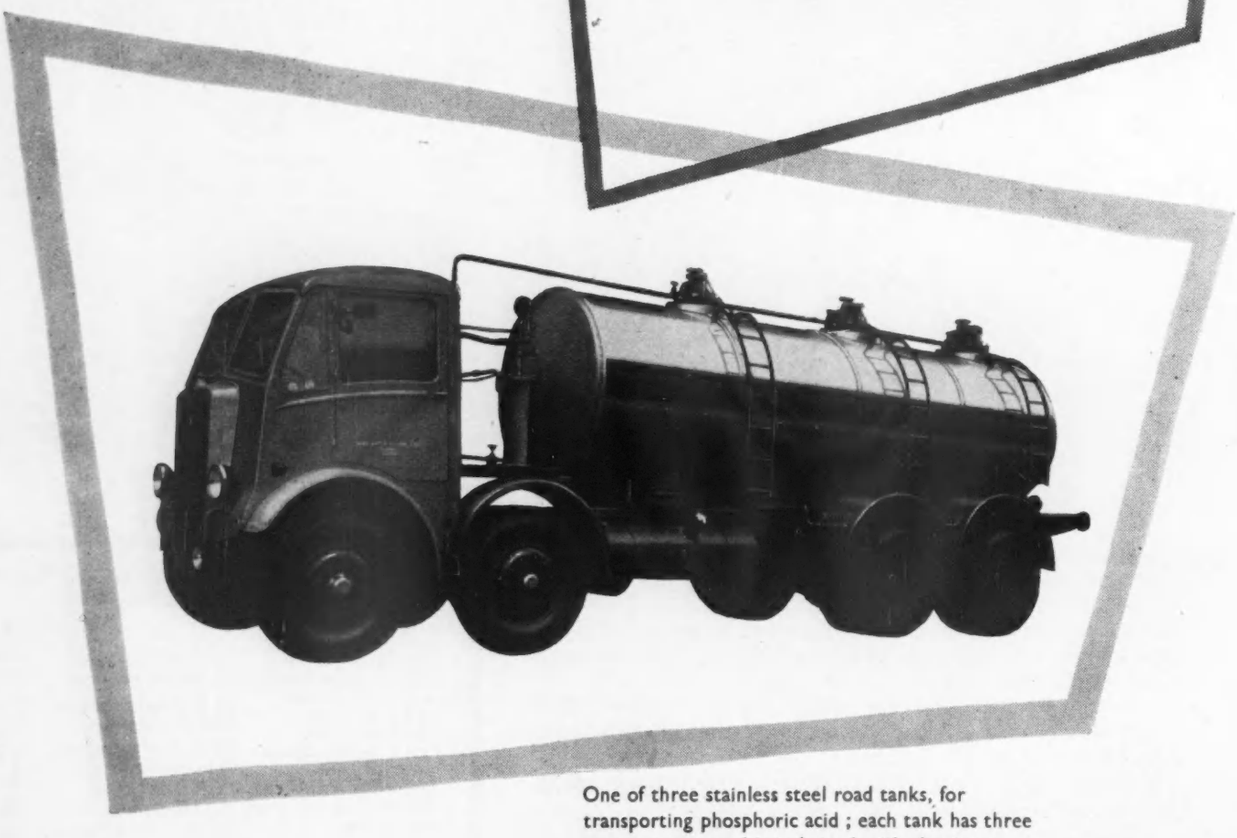

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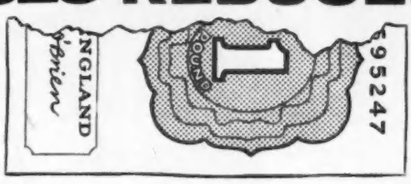

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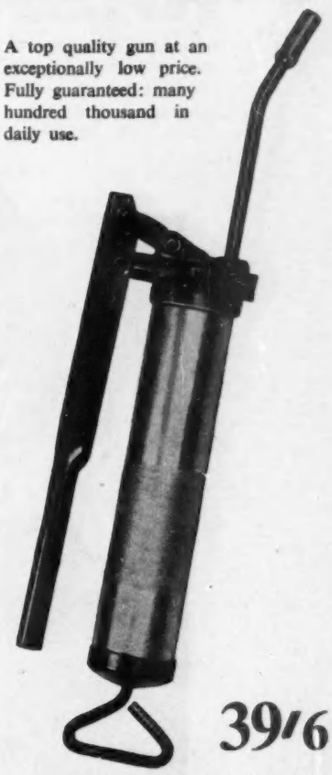

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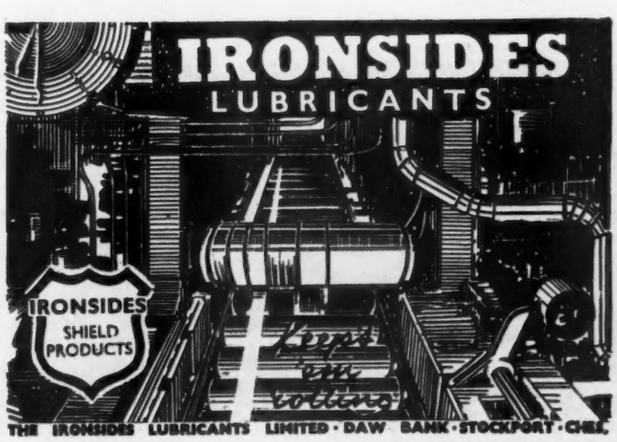

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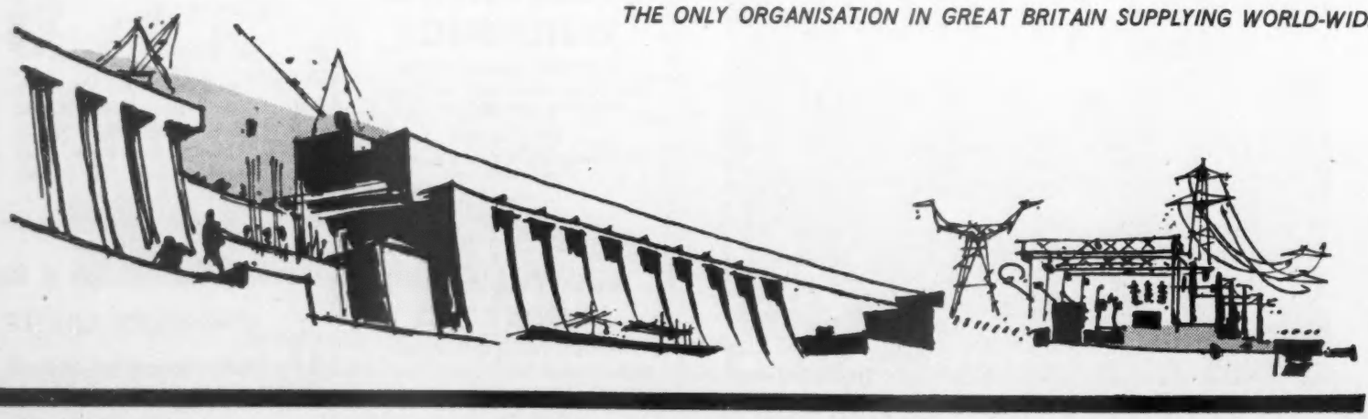

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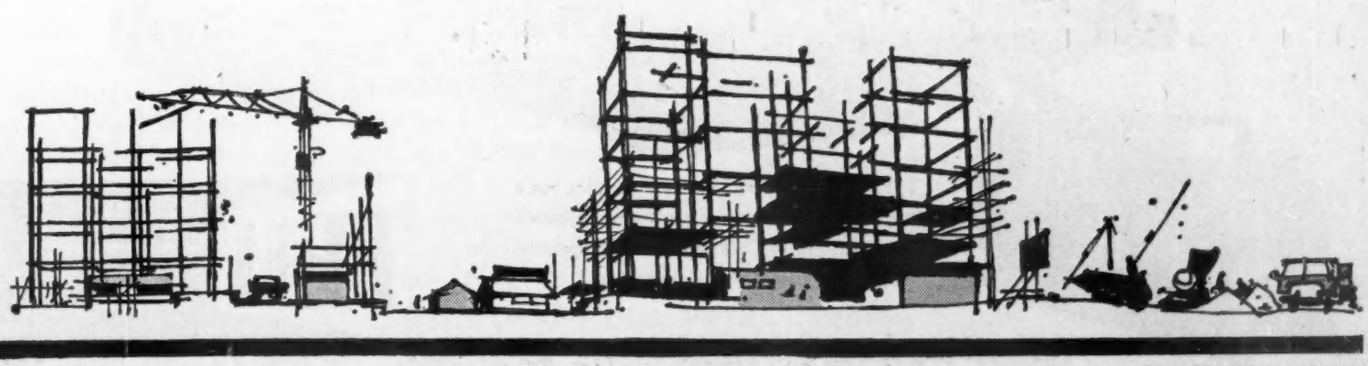

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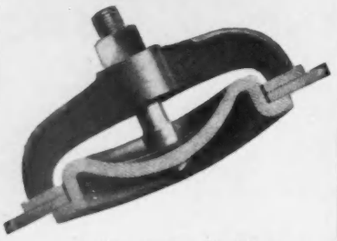

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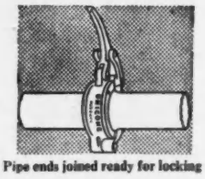

Pipe ends joined ready for locking

The completed joint.

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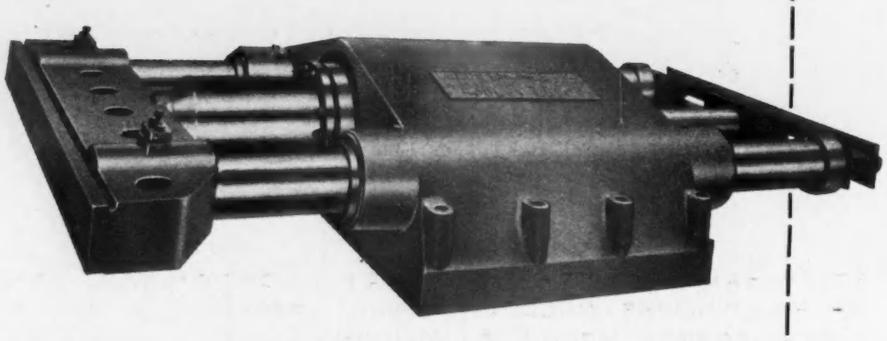

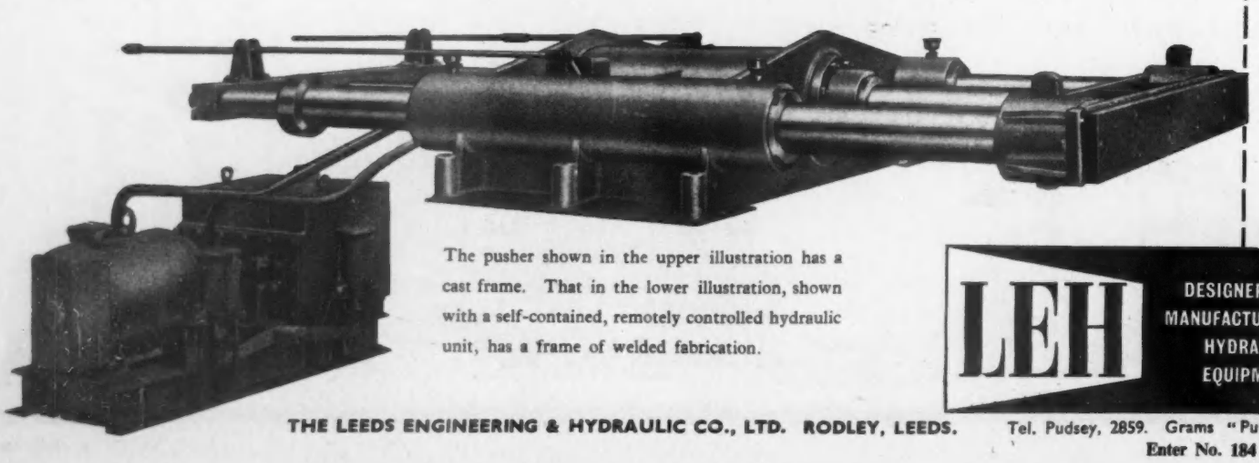

The pusher shown in the upper illustration has a cast frame. That in the lower illustration, shown with a self-contained, remotely controlled hydraulic unit, has a frame of welded fabrication.

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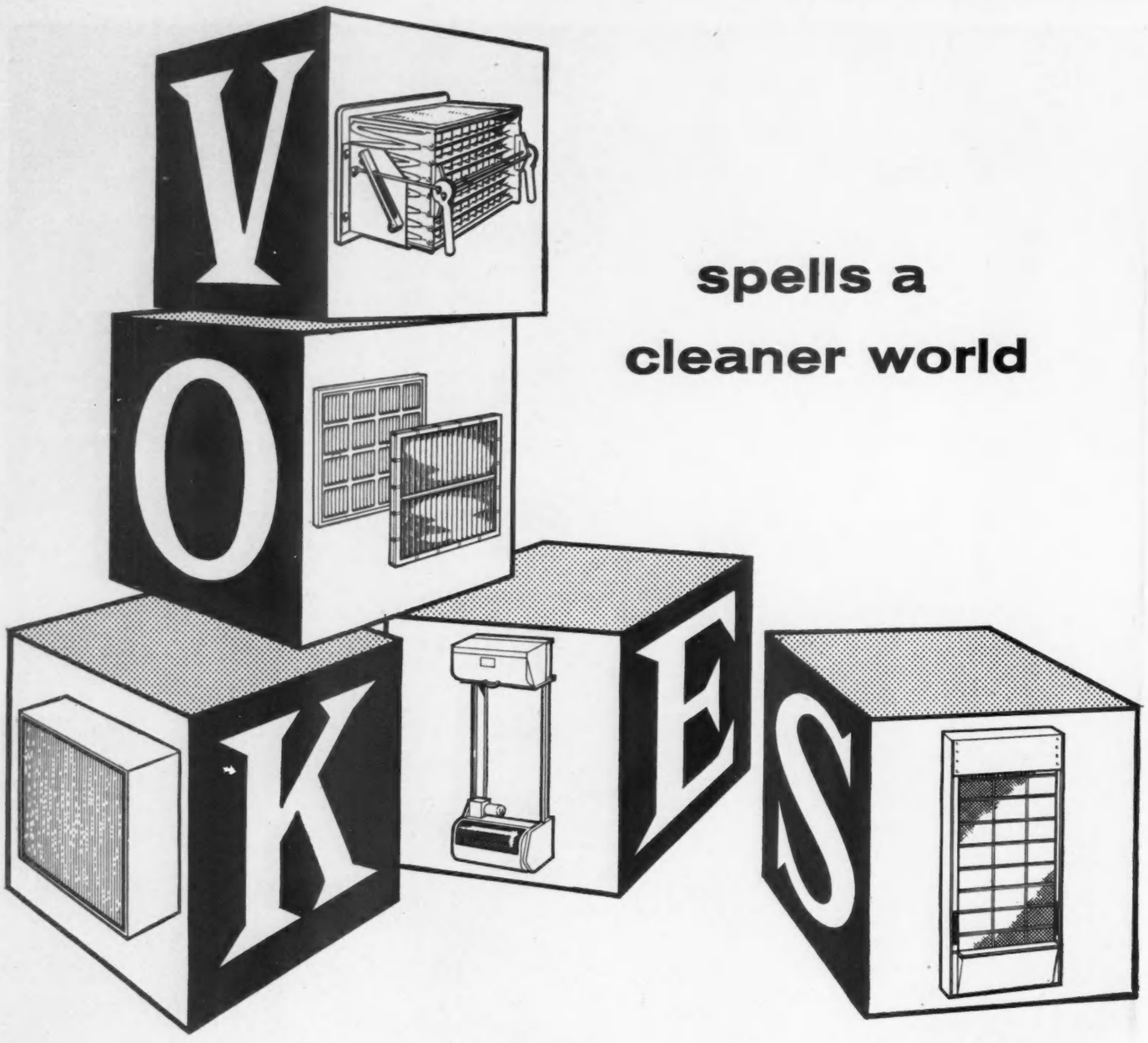

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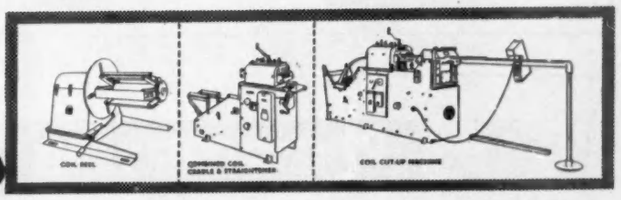

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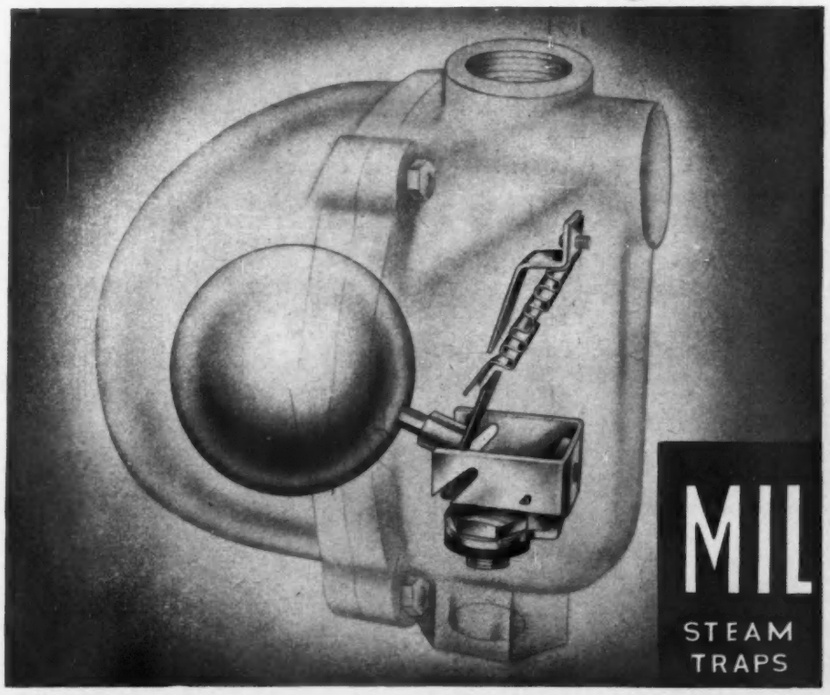

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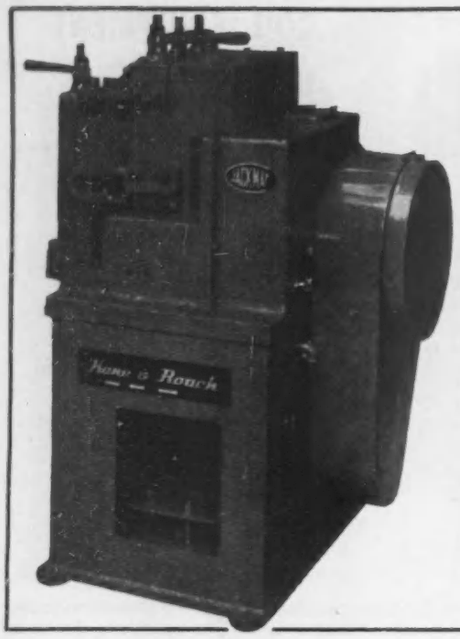

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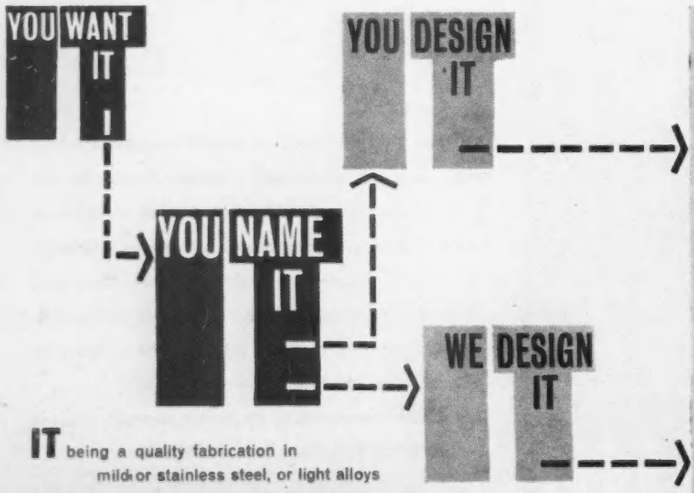
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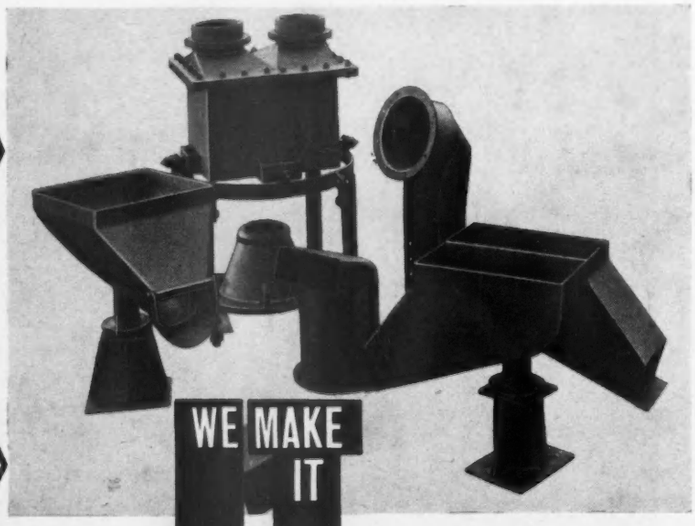

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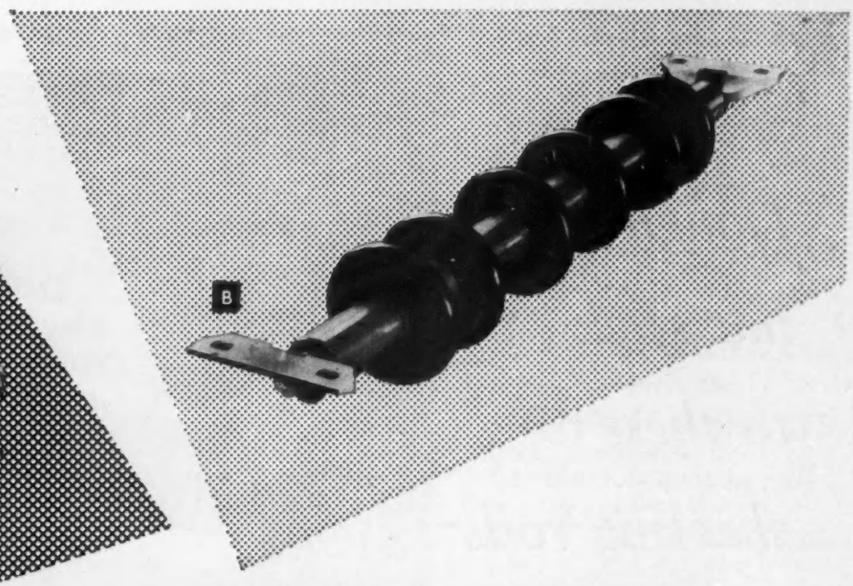

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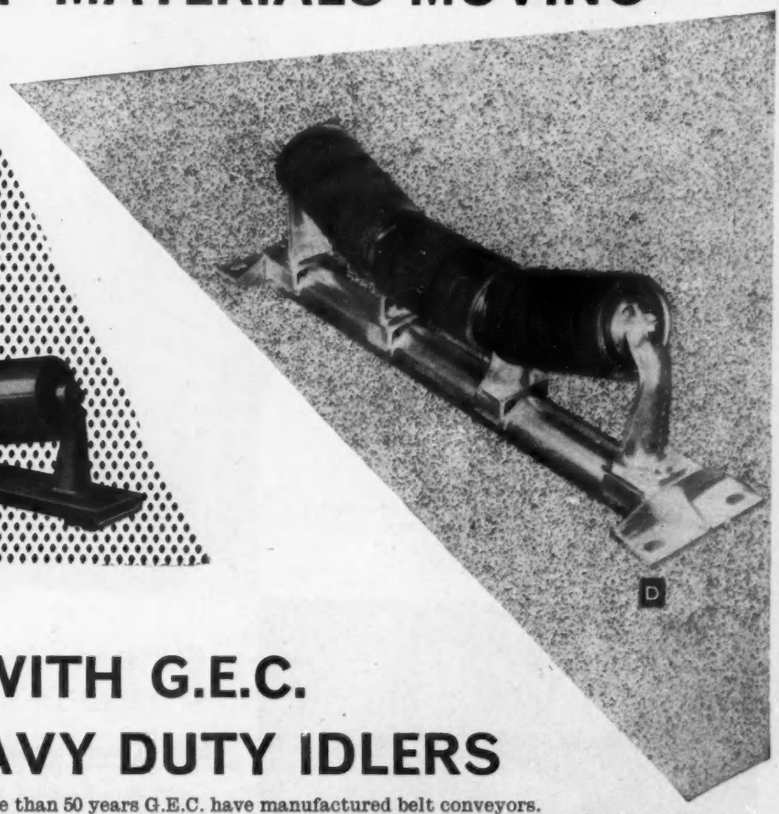

A *6" diameter steel tube troughing idler and return idler.* Rollers are made from mild steel tube 6" outside dia. and 6 s.w.g. Strong, rolled section steel idler base board. All troughing idlers, except on reversible belts, provided with tilting blocks to aid training of the belt.

B *7½" diameter rubber disc return idler.* Tube carrying discs is solid drawn 6 s.w.g. and 3" outside dia. Discs are strengthened internally with mild steel ring and remain rigidly in position. Idler especially suitable where damp and sticky materials are handled.

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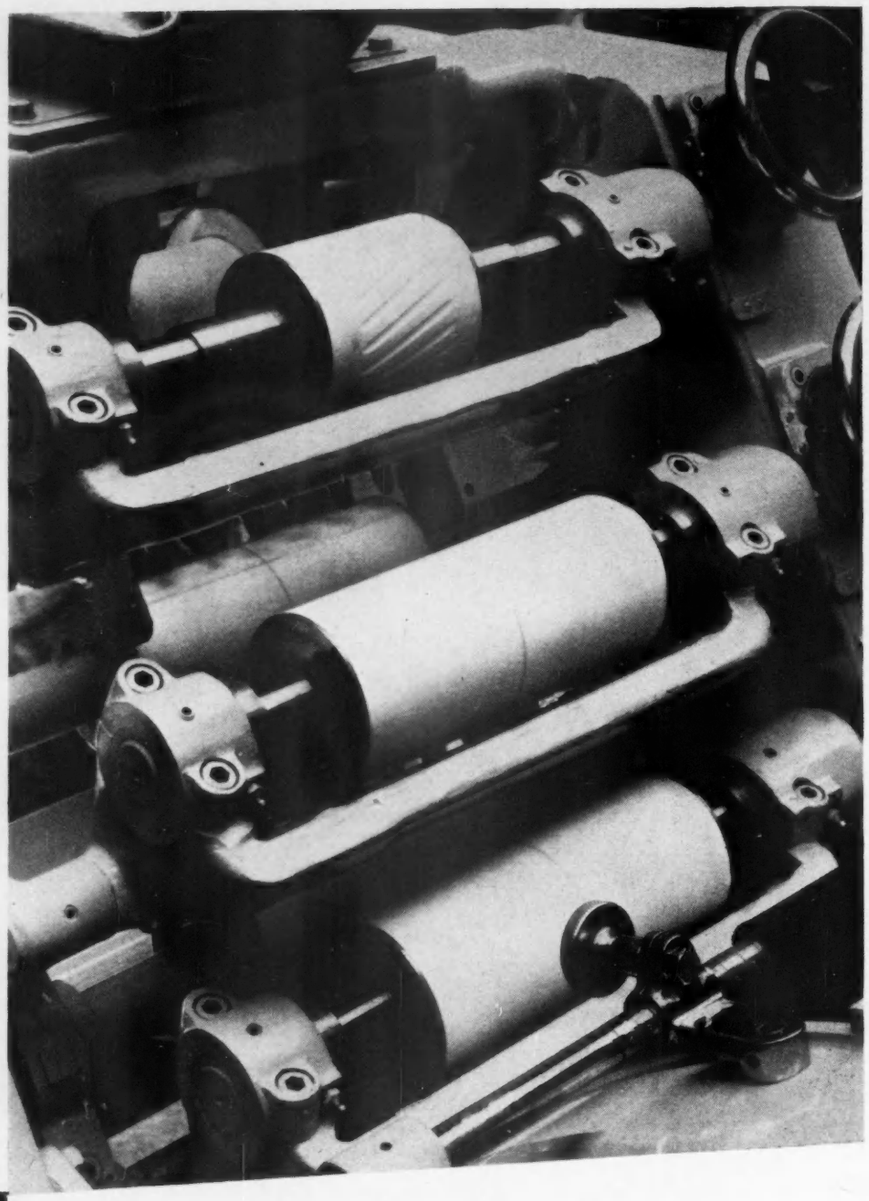
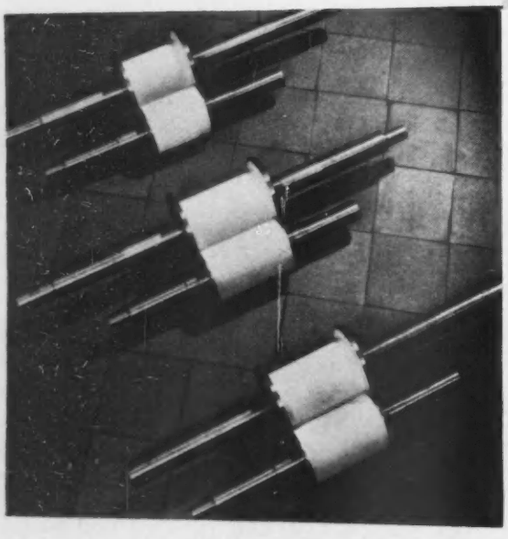


On the right: heavy duty drum moulder made by Baker Perkins Ltd., Peterborough, on which the sheeting rolls are covered by James Walker & Co. Ltd., Woking, with sleeves made from 'Fluon' p.t.f.e.

Below: three pairs of sheeting rolls for heavy duty drum moulder showing sleeves made from 'Fluon' p.t.f.e.



SHEETING rolls on a heavy duty drum moulder made by Baker Perkins Limited, Peterborough, are covered with sleeves made from 'Fluon' p.t.f.e. by James Walker & Co. Ltd. Because 'Fluon' is used, dough will not stick to the rolls. This means wastage of dough is reduced. It means, too, that the machine can run continuously because it does not need to be stopped for the rollers to be scraped clean.

'Fluon' is hygienic and will not taint food. It is tough and flexible and has an extremely wide working temperature range.

'FLUON'

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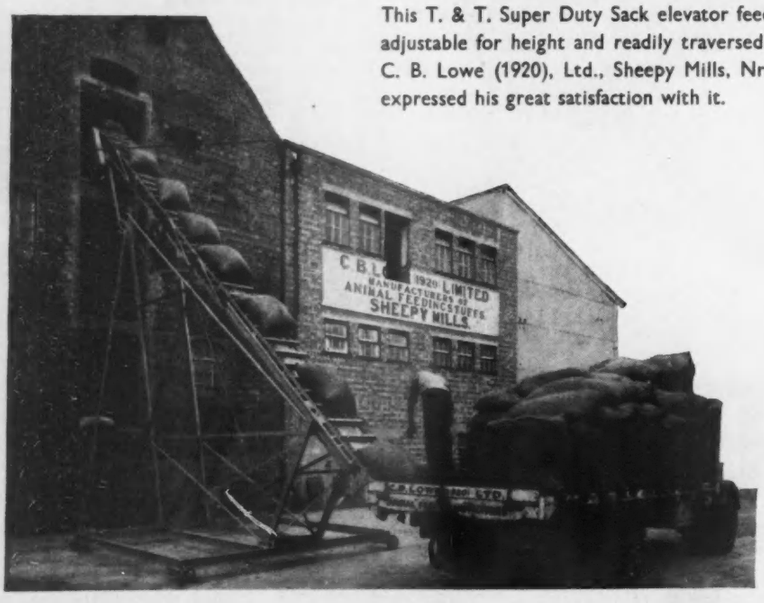

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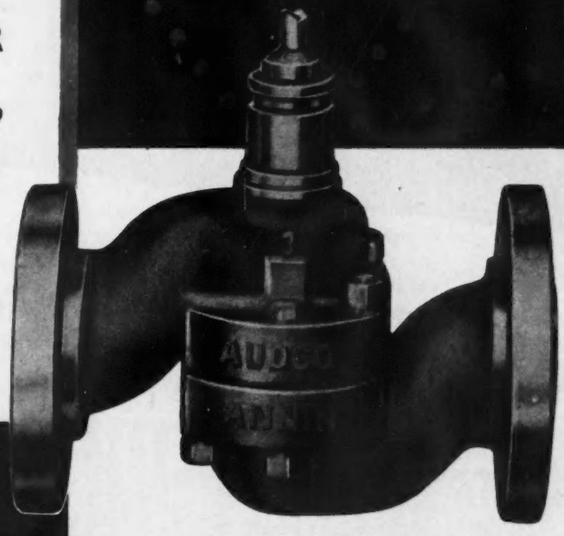

Applications unlimited through the interchange of components.

★ ***Complete range of valves up to 2500 ASA rating.***

The design and construction features shown in this exploded view demonstrate the flexibility of Audco Annin Valves. Three types of operator (Domotor, Cylinder or Manual) and five types of packing assemblies (plain extension, doolseal, bellows seal, cooling fin and standard) are interchangeable on one yoke and one body.

AUDLEY ENGINEERING COMPANY LIMITED, NEWPORT, SHROPSHIRE.
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Taylor Lo-Hed

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the loads
in your
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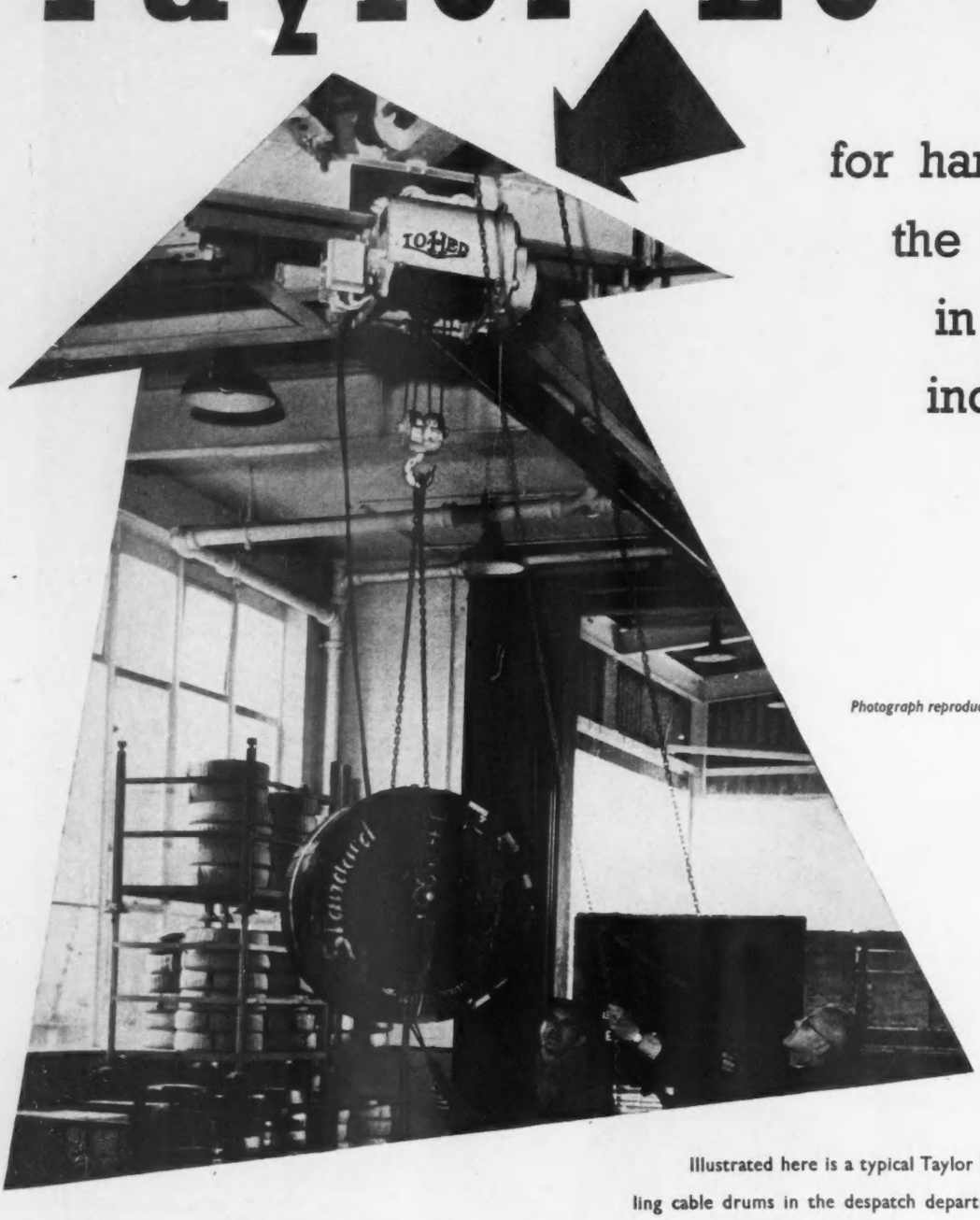

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Illustrated here is a typical Taylor Lo-Hed Hoist installation for handling cable drums in the despatch department.

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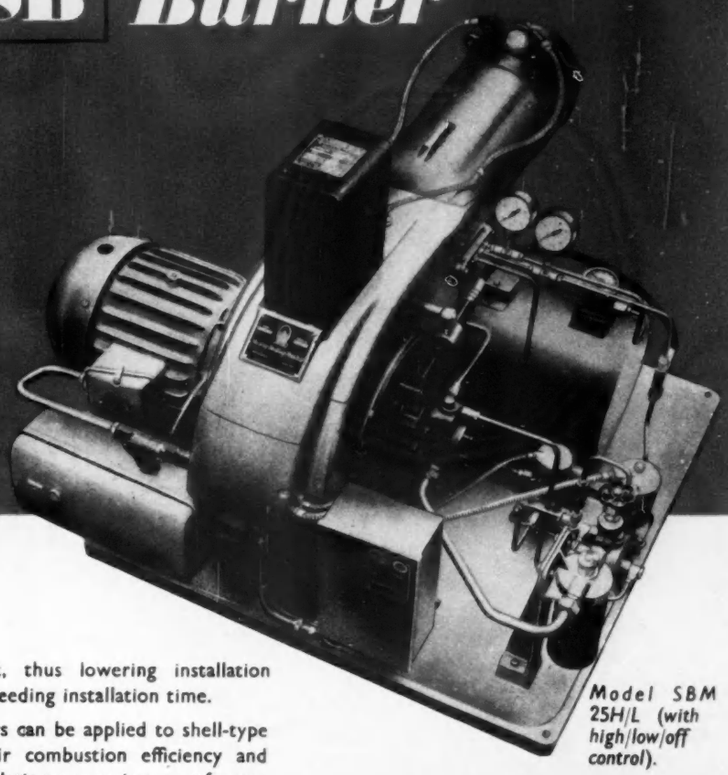
Introducing the NU-WAY SB *Burner*

Another Nu-way thoroughbred! by EXPERIENCE out of MODEL ZH



Model SBM 25H/L (with high/low/off control).

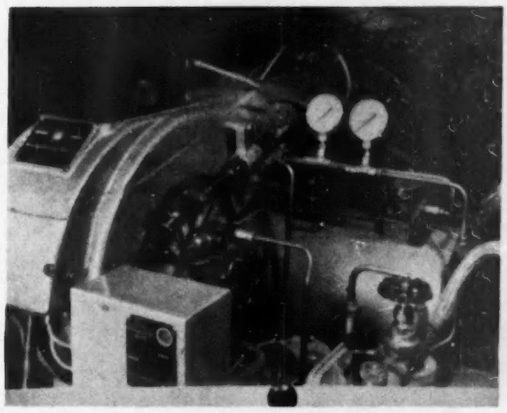
Developed from the Model ZH, Nu-way's outstandingly successful series of fully automatic commercial burners, the new SB models are primarily intended for the efficient firing of steam boilers at lower capital cost. SB burners are also particularly suitable for firing any other boilers which offer high resistance to the flow of combustion gases. To achieve this the fan pressure on the SB design has been substantially increased to produce a convergent air blast at the nozzle which is strong enough to play a significant part in atomising the oil and promoting rapidly completed combustion. The resulting flue gas velocity is high enough to overcome very substantial boiler and flue resistance which would cause ordinary burners to pulsate and smoke.

One important advantage of this new atomising system is that the combustion chamber volume required for a given rate of firing is greatly reduced. Vertical boilers fired with the SB burners can usually accommodate a fire-box of sufficient size without excavation or extending the boiler skirt, thus lowering installation costs and speeding installation time.

SB burners can be applied to shell-type boilers, their combustion efficiency and cost of installation comparing most favourably with other more cumbersome oil-firing systems.

These new burners are now being produced in a wide range of sizes for different grades of fuel. The various groups are : Model SBL, for light distillate oils and Models SBM and SBH for medium and heavy fuel oils respectively.

Full details of Models SBM and SBH are given in our, newly published, Data Sheet No. D7A. Details of Models SBL are in course of publication pending which advance information will be supplied upon request. All but the smallest SB burners can be supplied with Nu-way High/Low/Off control. This high/low flame equipment which is standard on all larger SB models gives appreciable fuel savings, inhibits pulsation on light-up and stabilizes steam pressure.



Close-up of a typical SB burner application. Showing a Model SB17 H/L burner firing a Cochran boiler of 1500 lb./hr. evaporation, through the former stoking door. Note the ram-operated high/low air control on the fan inlet.

NU-WAY Oil-firing

Write for technical literature . . . NU-WAY HEATING PLANTS LTD. (BOX A923), DROITWICH.
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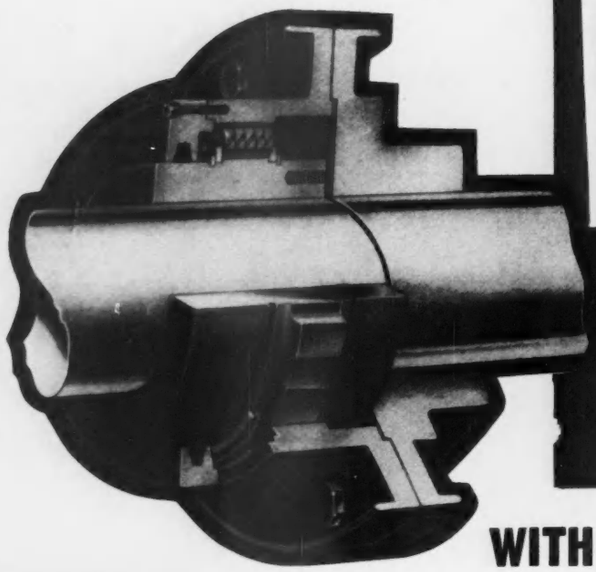

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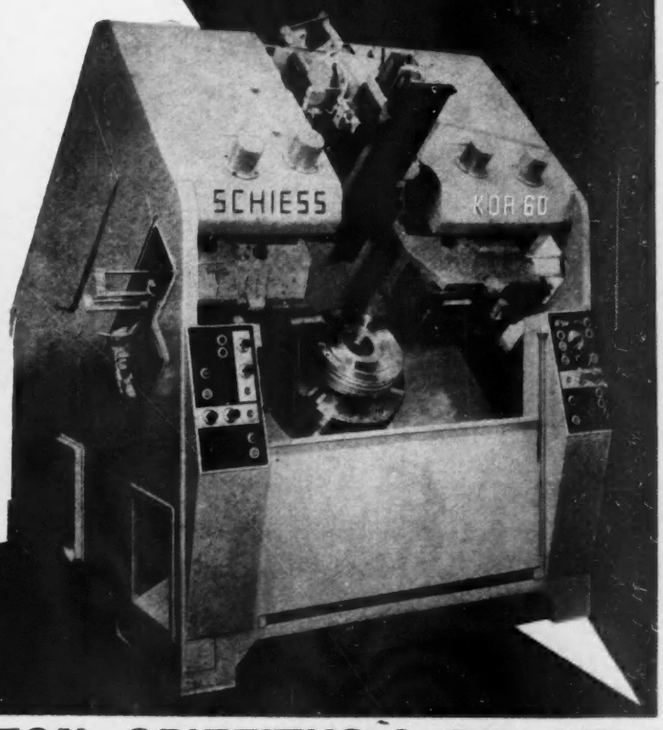

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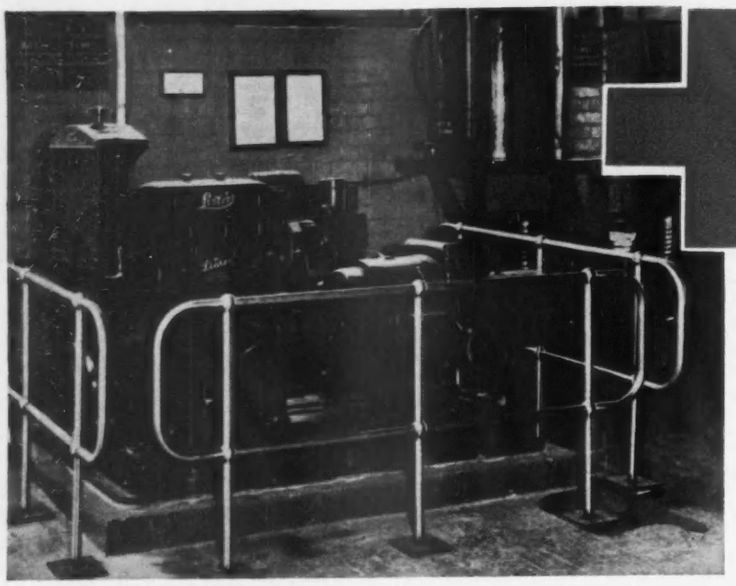

(*Above*) *Lister 12·5kW 400/230V. "mains failure" set providing a standby supply to the induced draught fans and auxiliaries in a boiler house at Whipps Cross Hospital, Leytonstone Hospital Group.*

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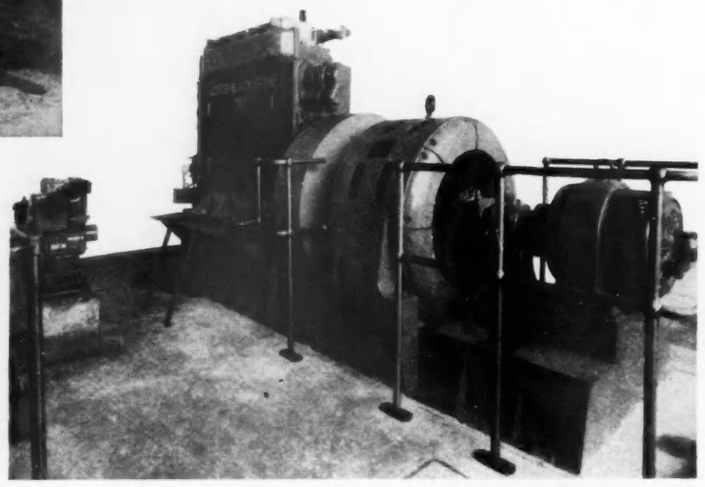

(*Right*) *135 h.p. 3-cylinder Blackstone diesel engine direct coupled to 93kVA (0·8 PF) alternator at St. David's Mental Hospital, Carmarthen.*

Write for details of other diesel engines from 3 to 1450 h.p.

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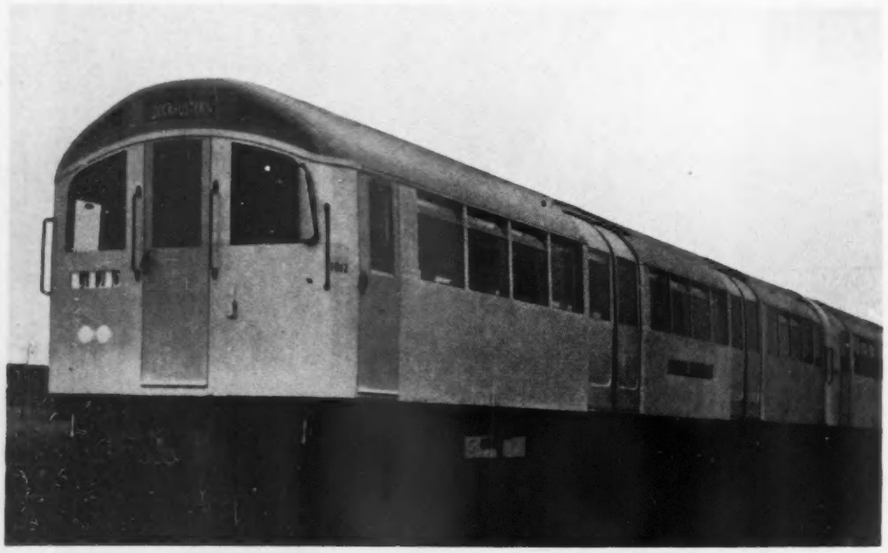

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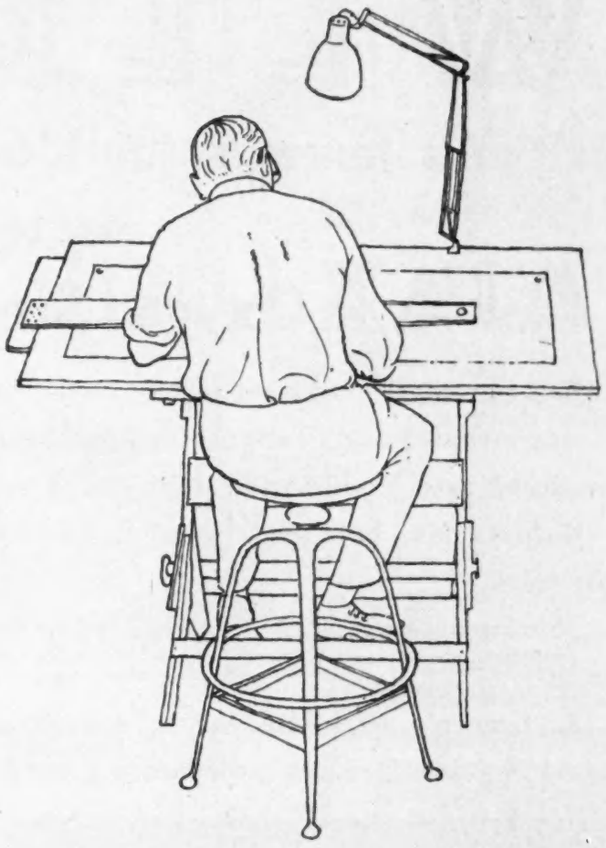

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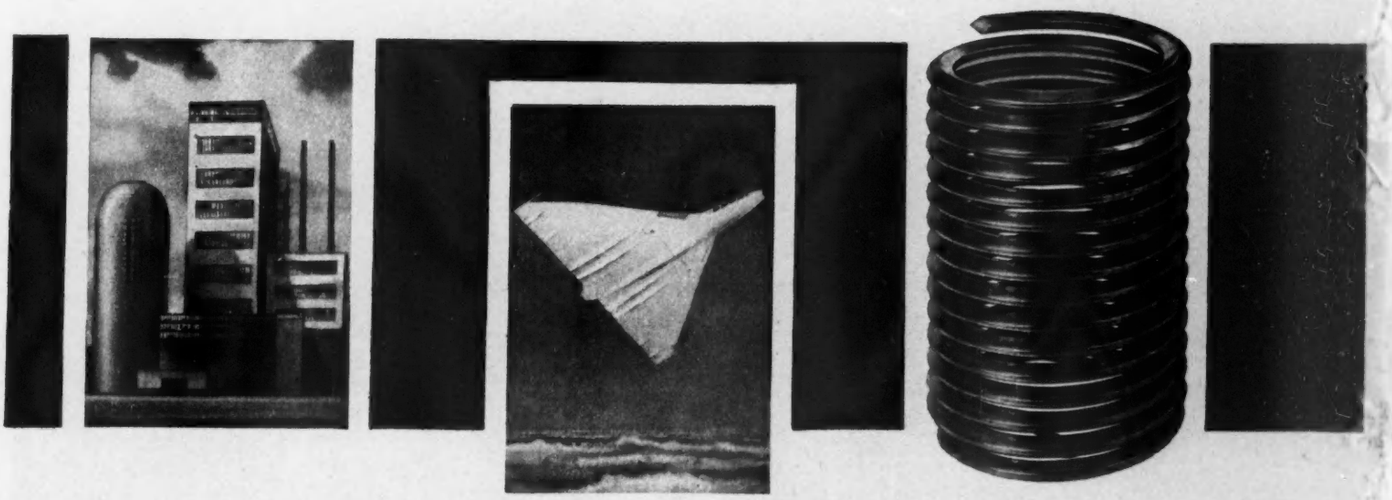

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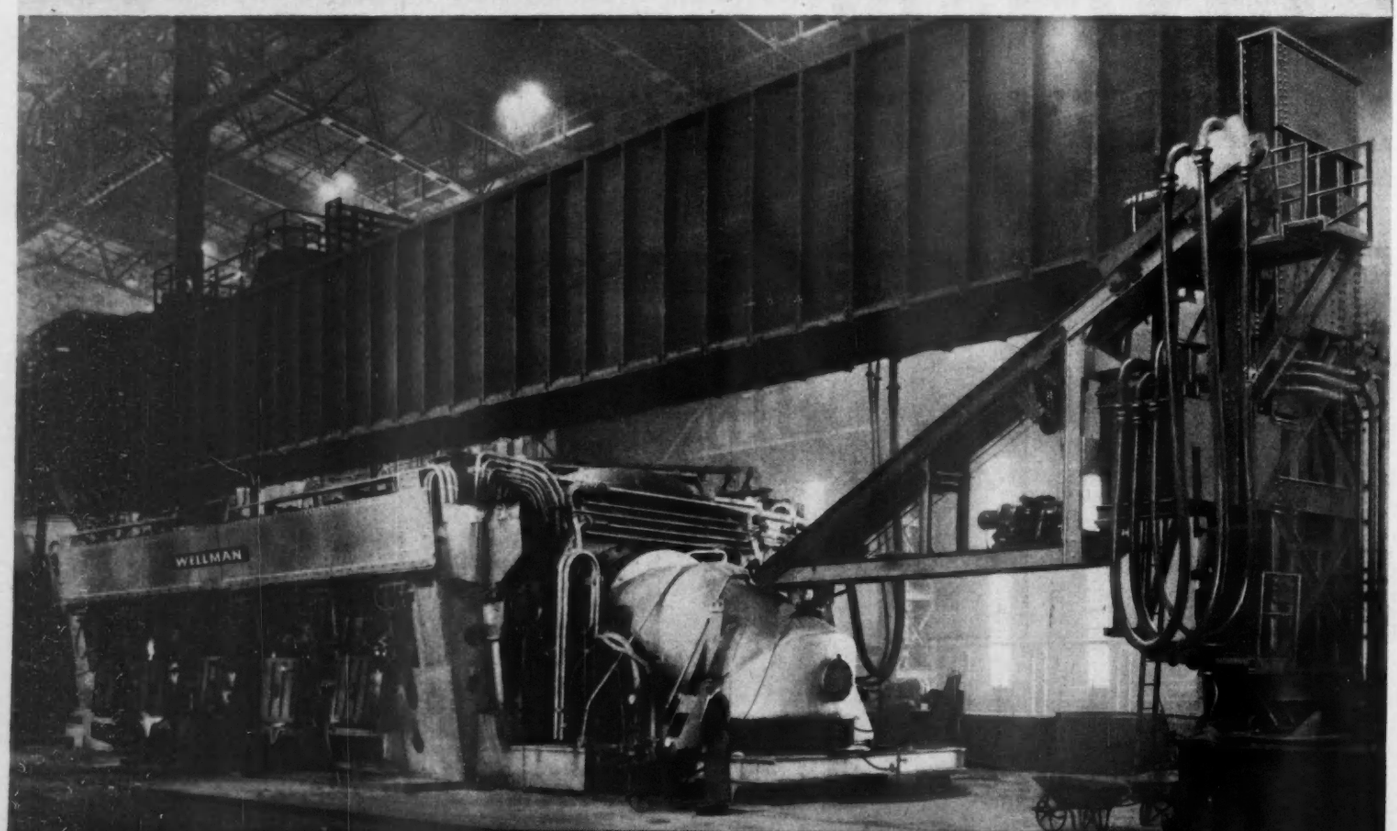

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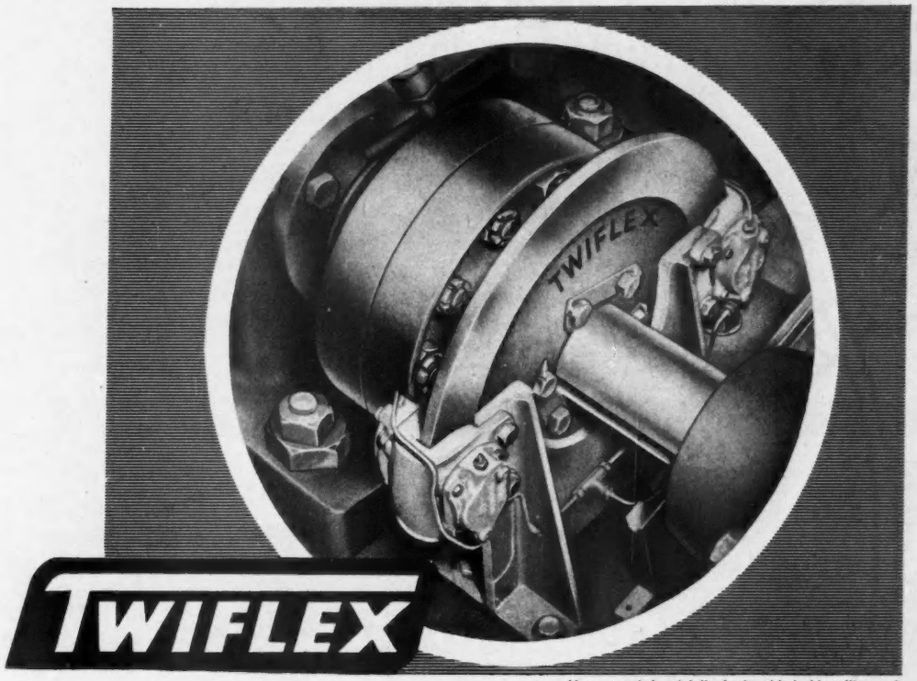

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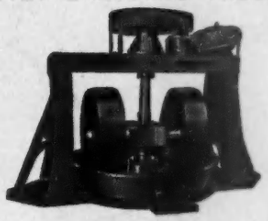

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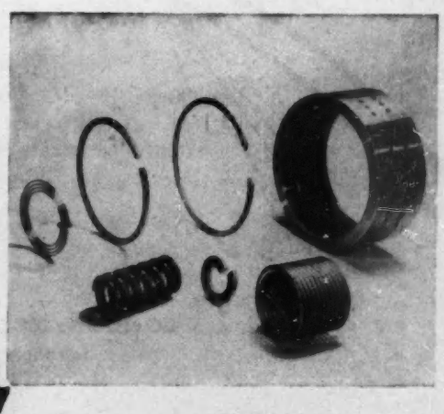

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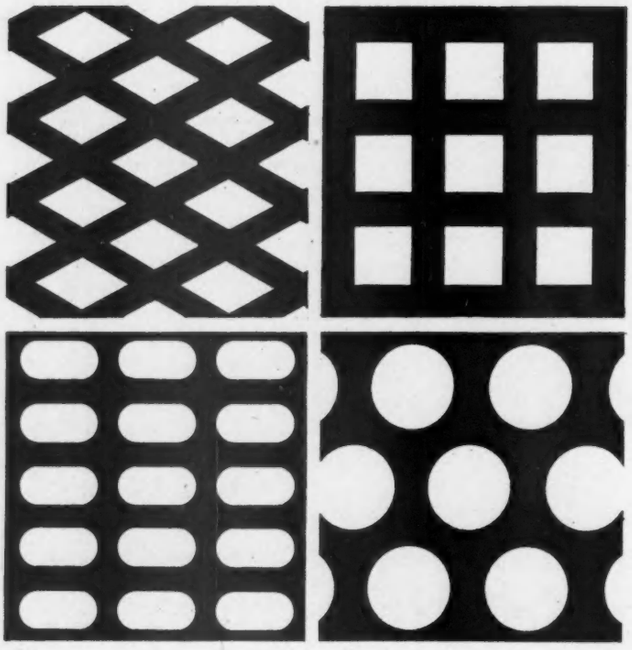

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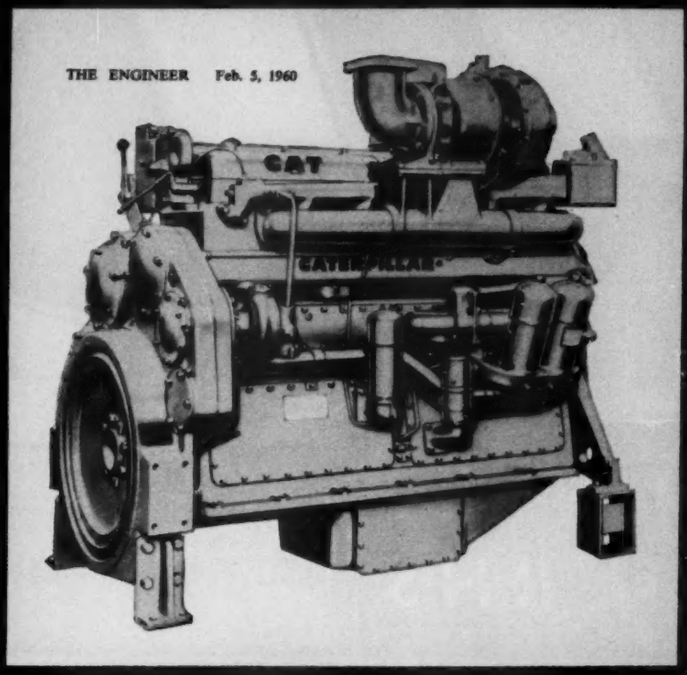

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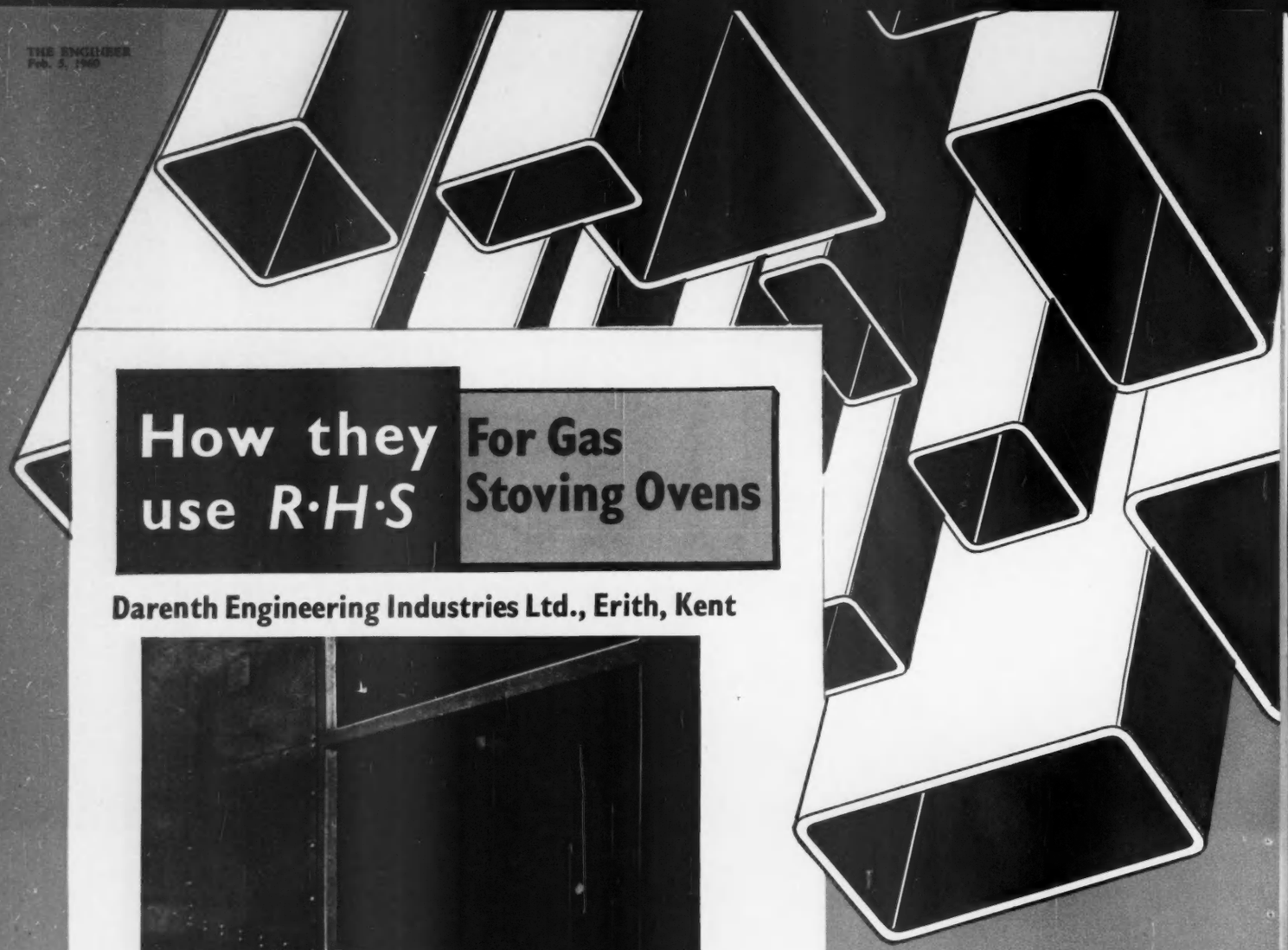

How they use *R·H·S* For Gas Stoving Ovens

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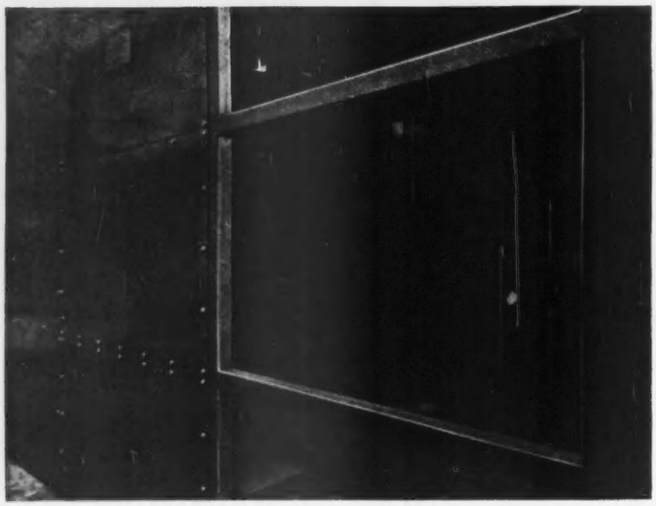

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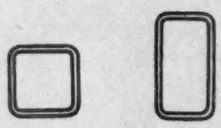

FROM	FROM
1″ x 1″	1⅞″ x 13/16″
TO	TO
5″ x 5″	6″ x 4″

R.H.S. ARE PRODUCED TO THE PHYSICAL PROPERTIES OF B.S. 1775 GRADE 16

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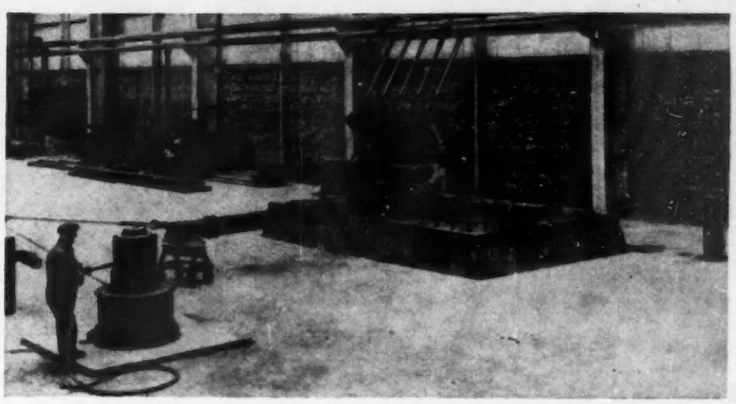

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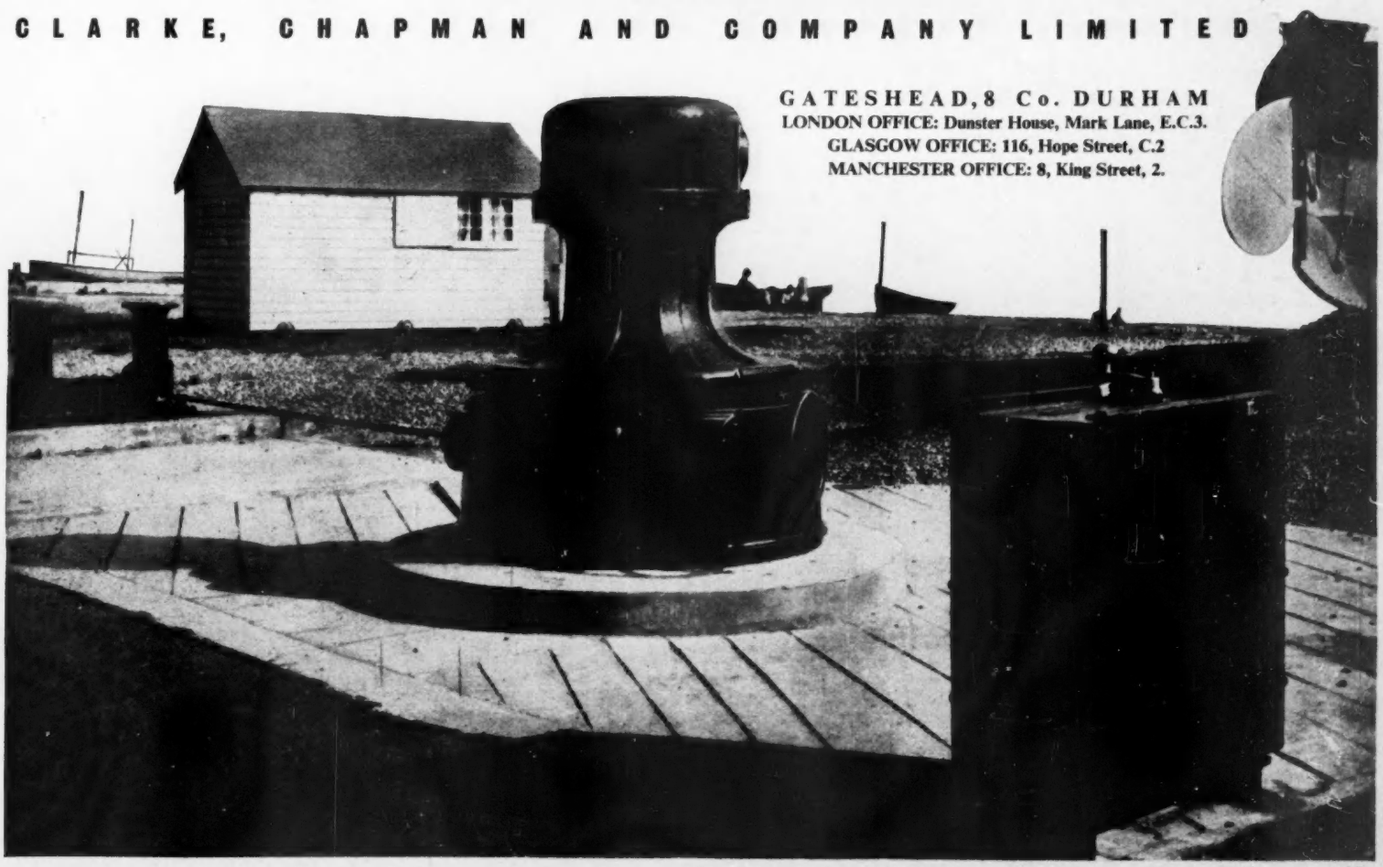

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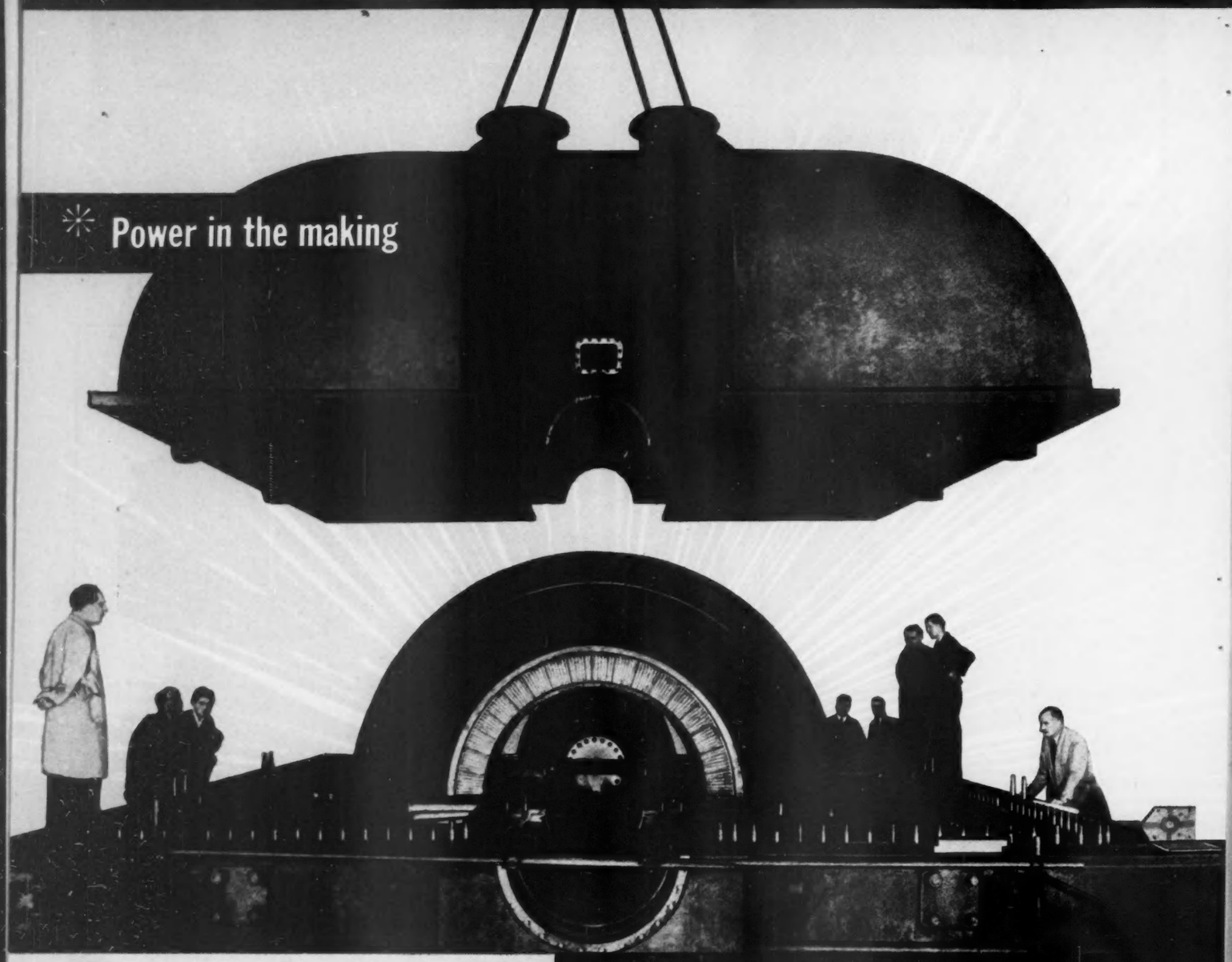

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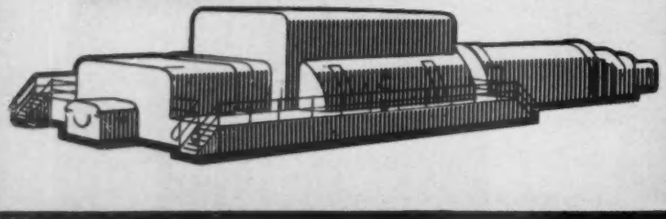

When Sir Charles Parsons produced the first steam turbo-generator he said that the larger the plant the more economical it would be. This is realised today with the tremendous electrical output of the very large turbo-generators under construction at PARSONS Heaton Works. Some idea of the size of the large and powerful steam turbine driving units can be seen from this view of the cover for a low pressure cylinder on a PARSONS 200 MW turbo-generator. The cover is being lowered for a trial fit prior to inclusion of the bladed shaft.

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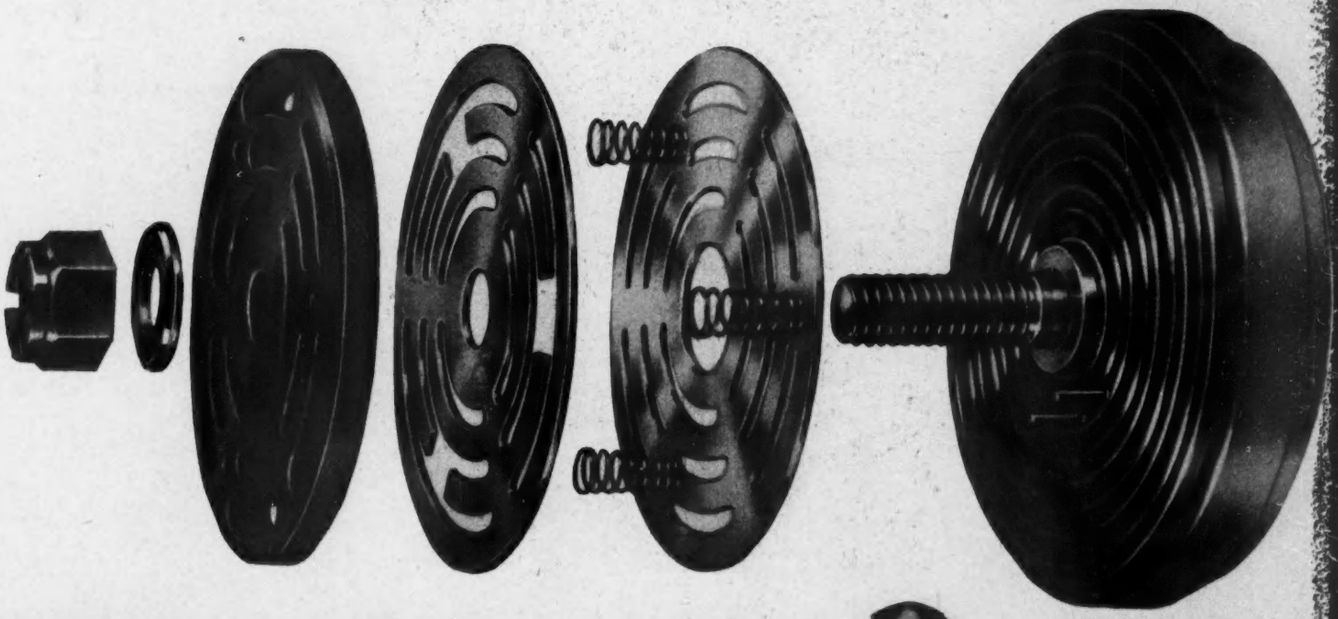

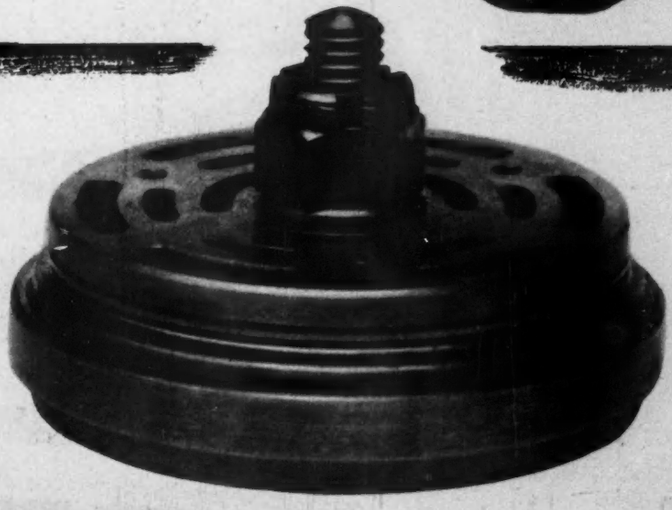

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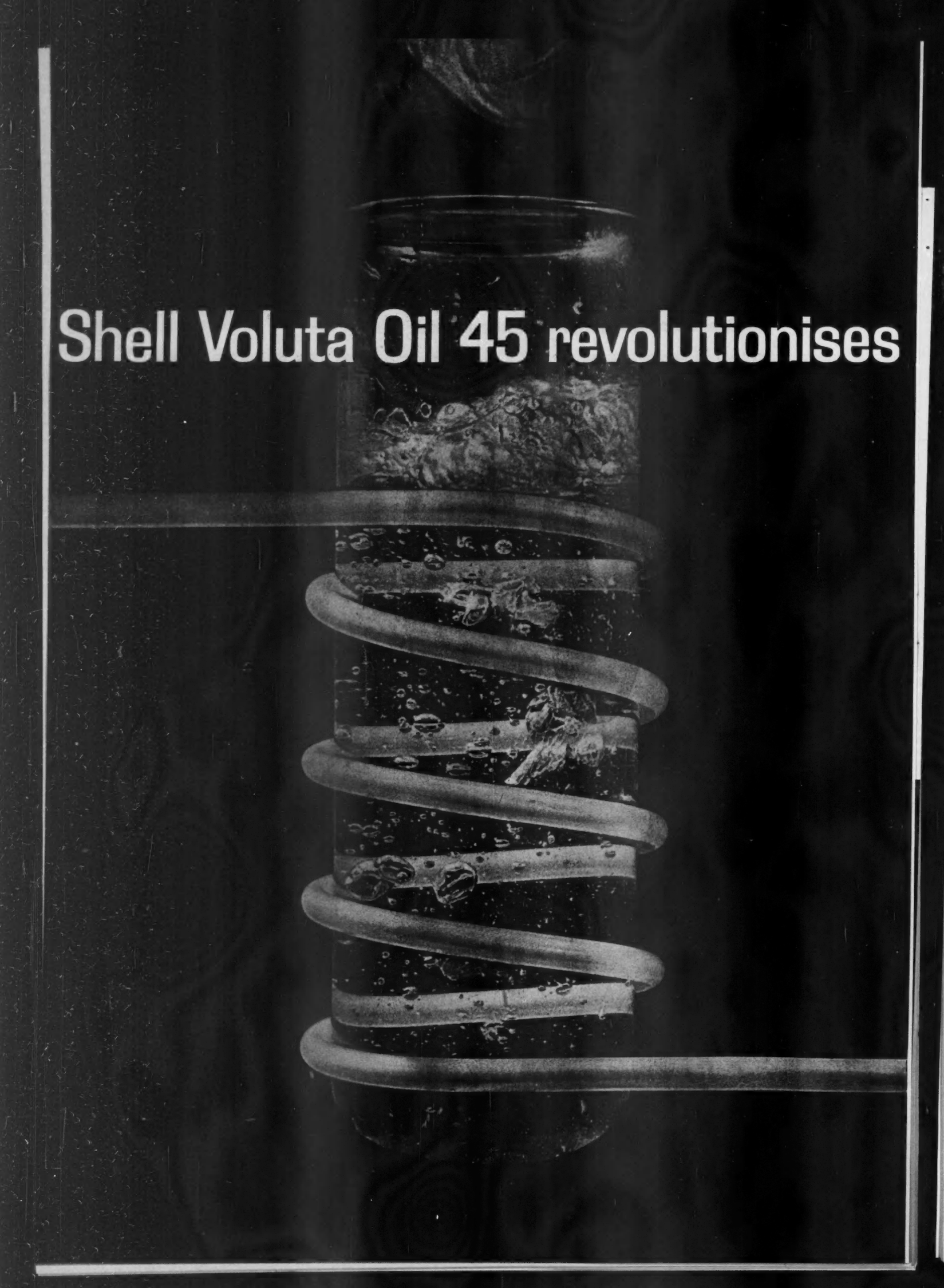

Shell Voluta Oil 45 revolutionises

heat exchange practice

Before Shell produced Voluta Oil 45 it was thought that oils which were to be used for heat exchange purposes must have a high flashpoint—to reduce fire risk—and a high viscosity to prevent excessive leakage through pump glands and to provide adequate lubrication for pump bearings at high temperatures. Heat exchange systems containing these viscous oils, however, were sluggish, particularly when started up from cold. The oil circulated slowly over the source of heat and suffered thermal decomposition, or "cracking". This, in turn, produced low flashpoint materials and carbon which insulated the heating surface.

Shell, therefore, began investigating the suitability of oils of lower viscosity and different chemical constitution. From this research was developed Shell Voluta 45.

Shell Voluta 45 contains hydro-carbons with a saturated ring structure which does not have the tendency that high viscosity straight chain paraffin hydrocarbons had—to break down at high temperatures. Because of its low viscosity Shell Voluta 45 heats up more quickly from cold and circulates more rapidly thus avoiding local overheating and thermal decomposition.

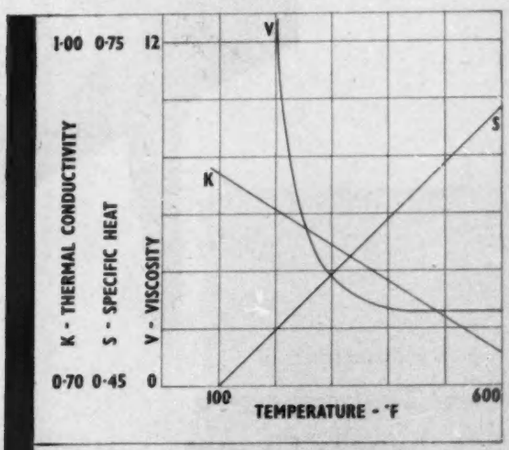
Shell Voluta Oil 45 has excellent heat transfer properties, good thermal stability and good lubricating properties. It is recommended for use in all closed heat transfer systems.

The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Laboratory research to compare the high temperature performance of various oils in a rig simulating practical conditions showed that when oils of varying viscosities were maintained at an average temperature of 325°C. for 200 hours, the closed flashpoint of the high viscosity oils had dropped to a lower figure than that of oils of lower viscosity, indicating that some thermal decomposition had taken place.

Experimental oils were subjected to Heat Stability Tests and to tests designed to measure the variation in heat transfer coefficient with time. The most promising of these oils was then given extensive field trials, both in Shell Installations and in industry. From this extensive research was developed Shell Voluta 45.



Physical properties of Shell Voluta Oil 45.
K. Thermal Conductivity—B.T.U./sq. ft. per hour per 1°F. per inch.
S. Specific Heat—B.T.U. per lb. per 1°F.
V. Viscosity—Kinematic centistokes.

SHELL

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another proof of Shell leadership in lubrication

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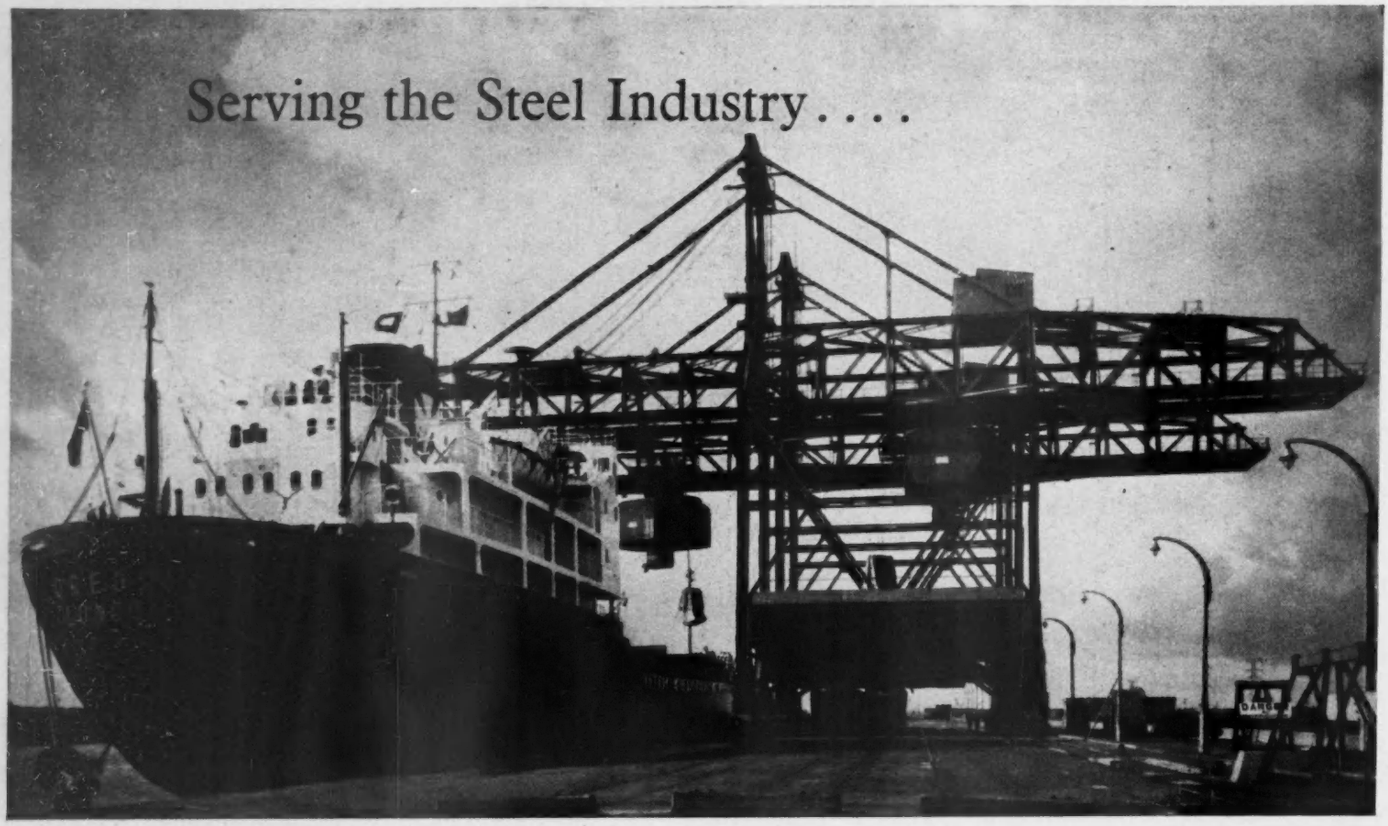

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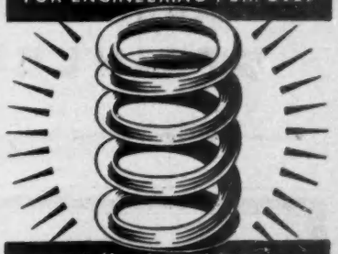

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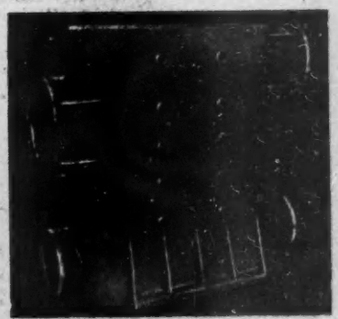

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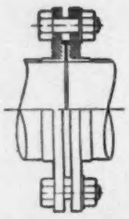

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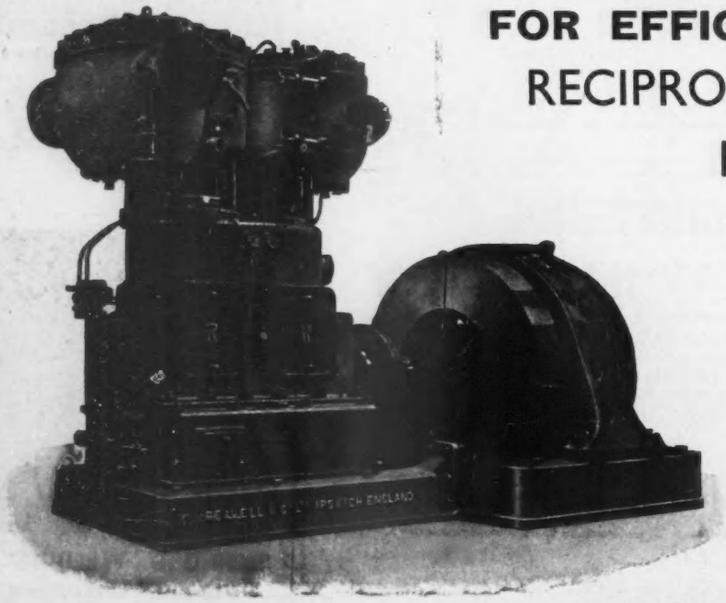

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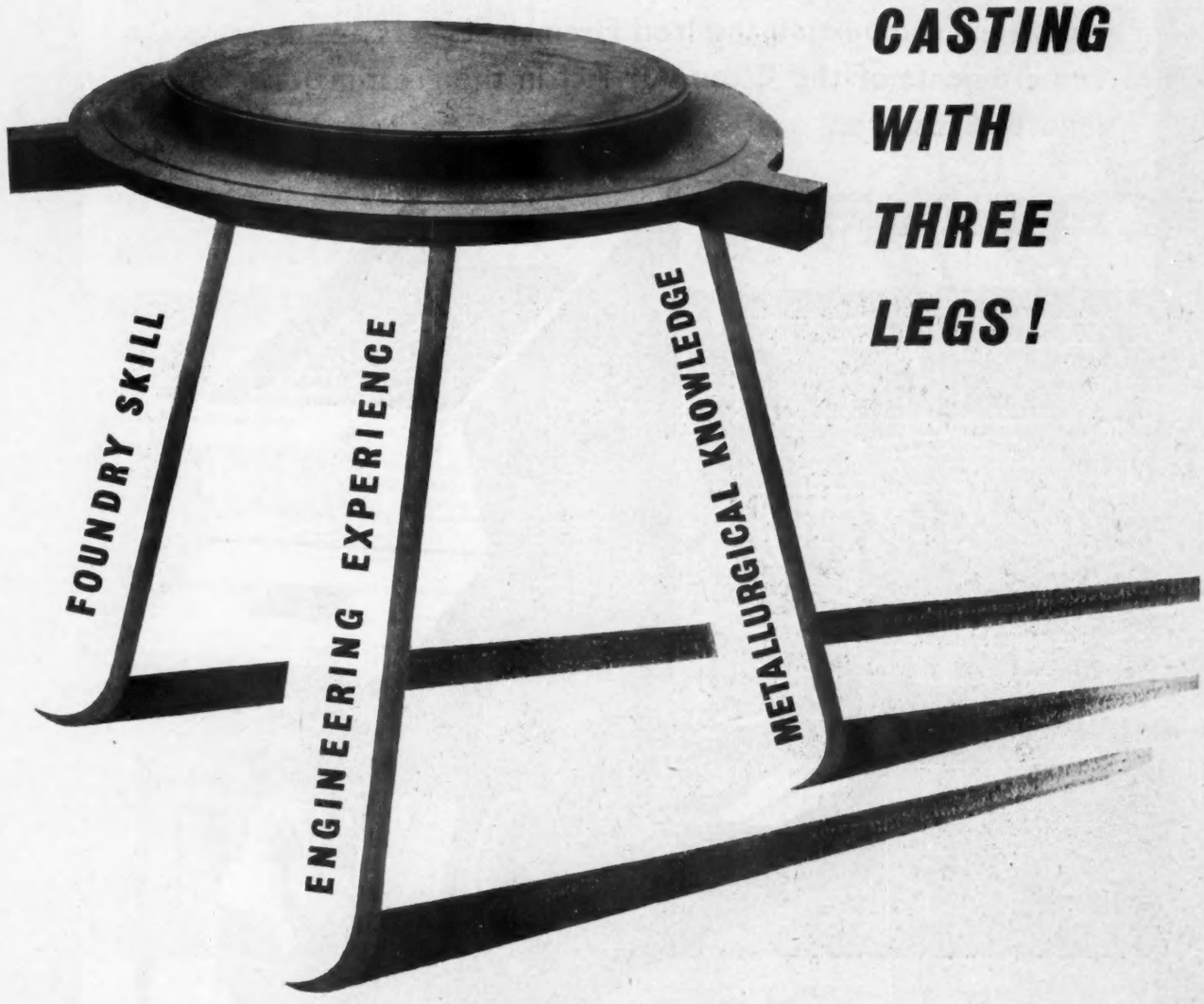

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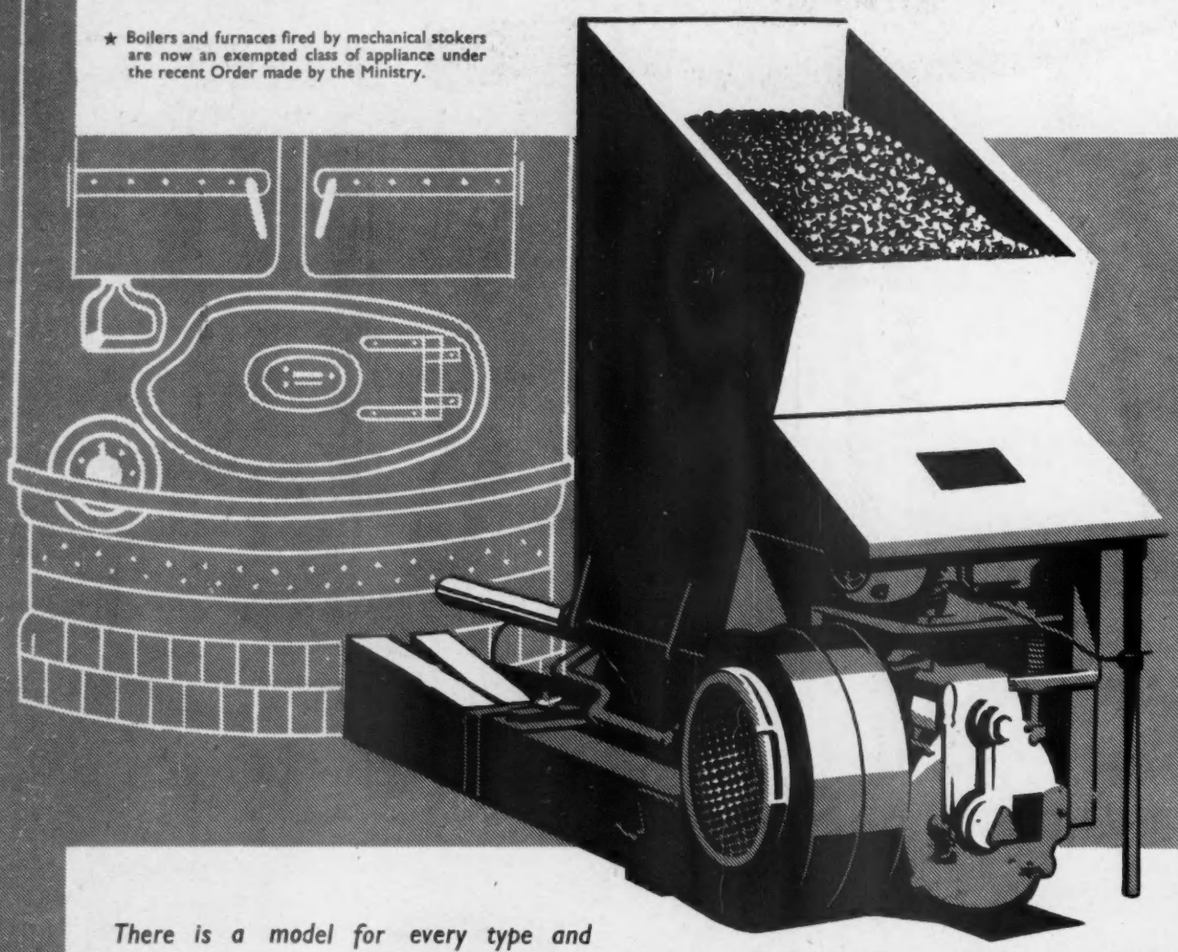

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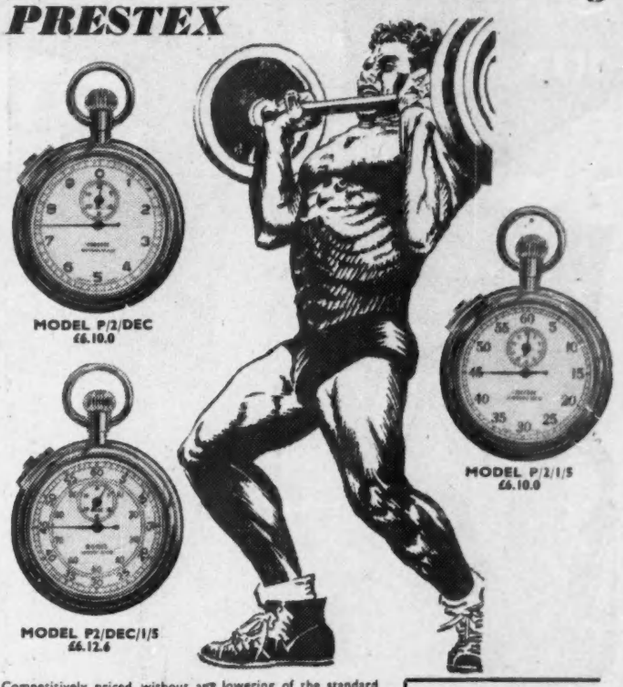

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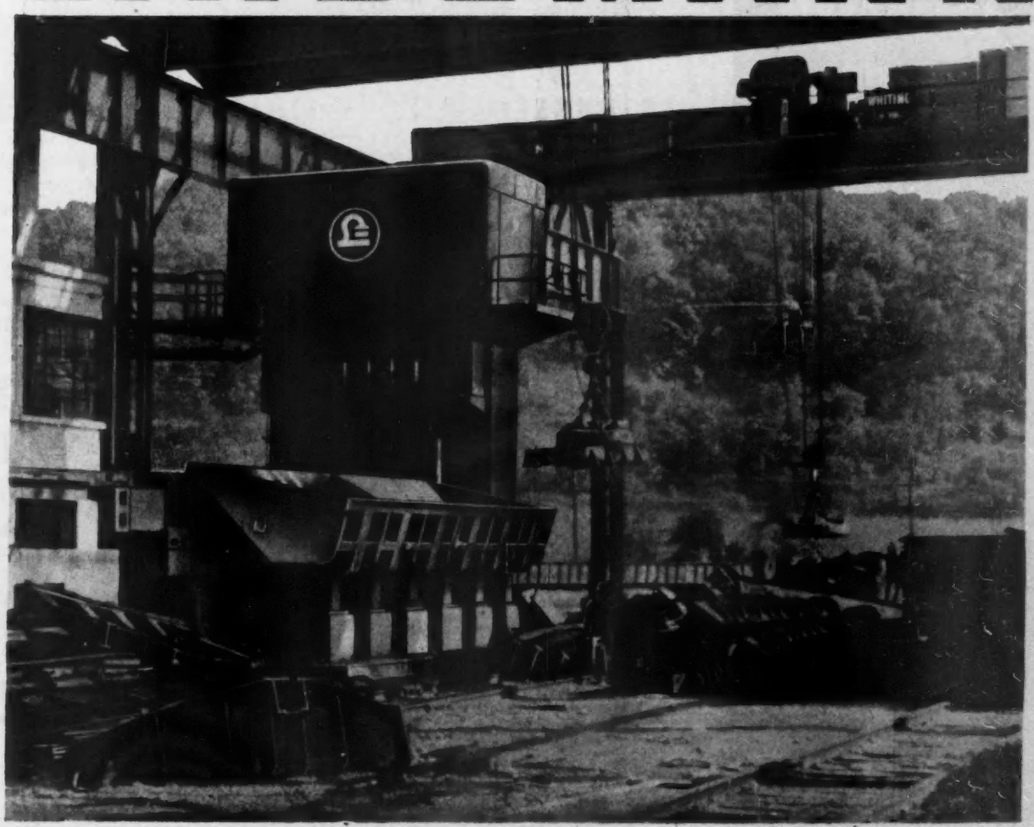

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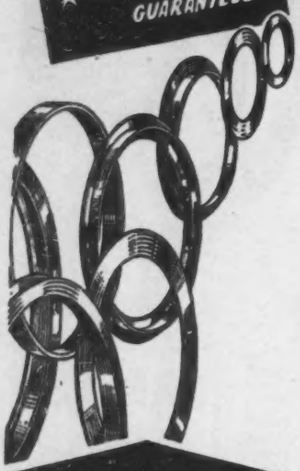

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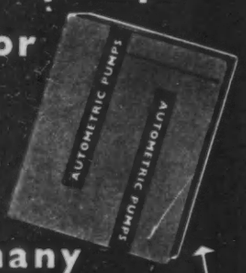

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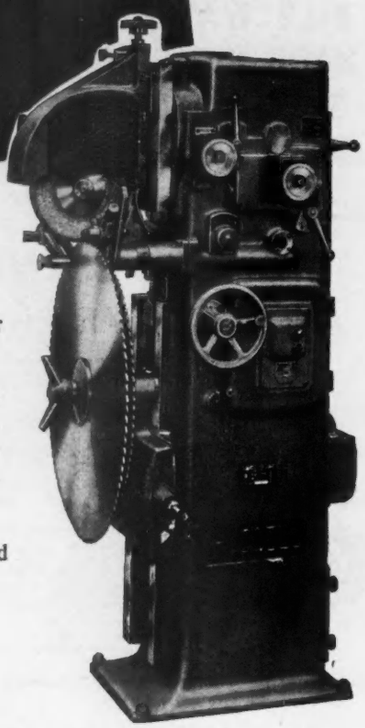

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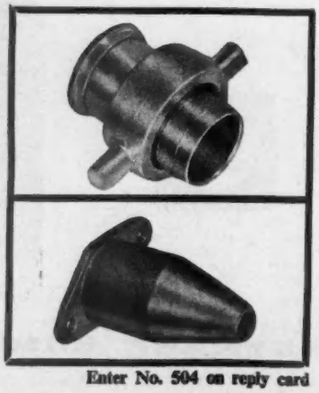

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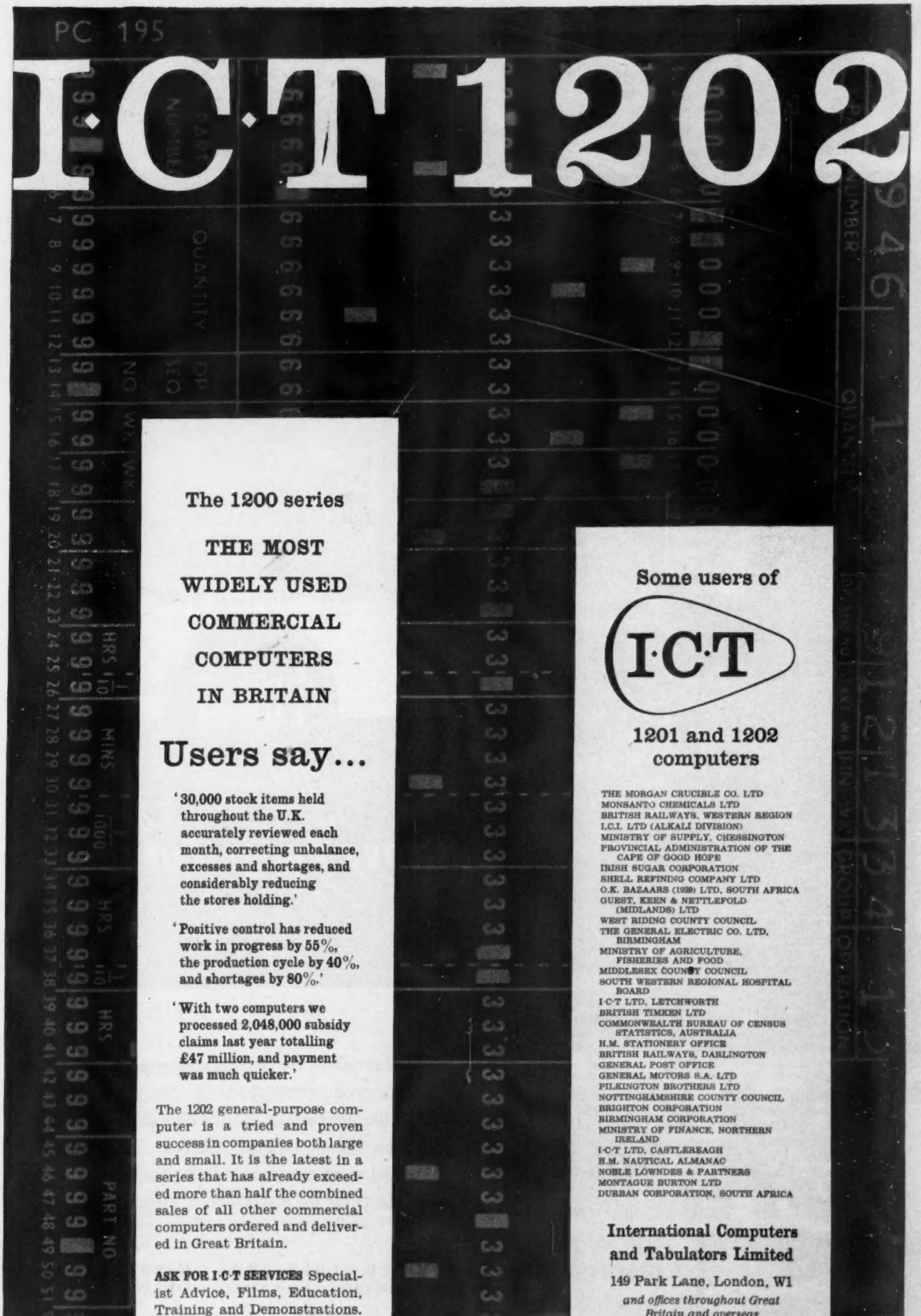

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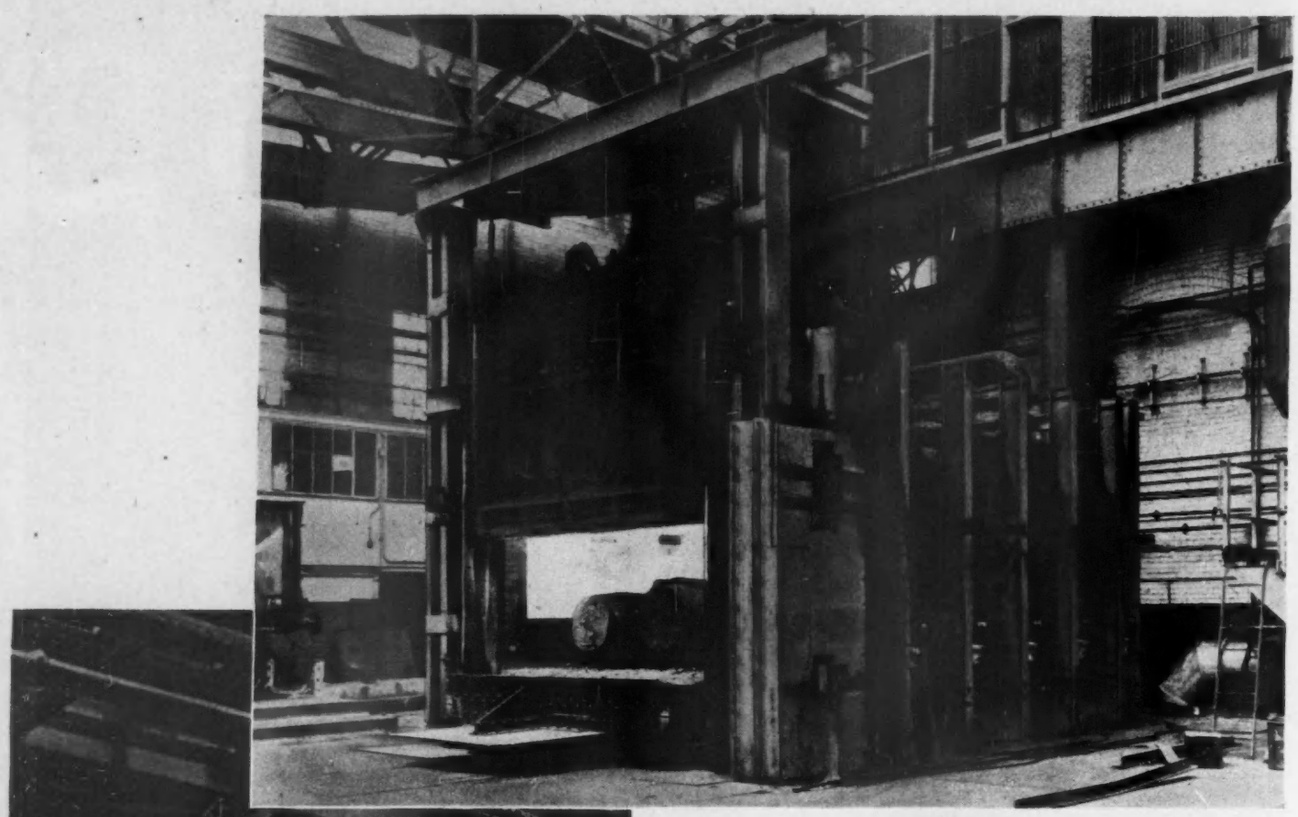

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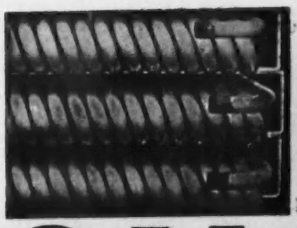

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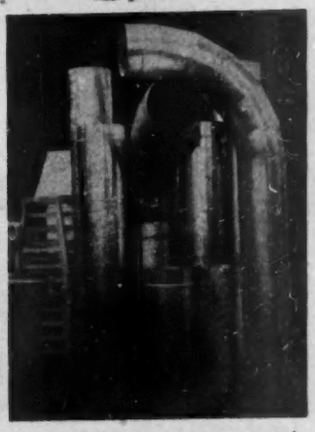

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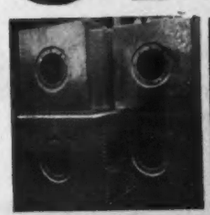

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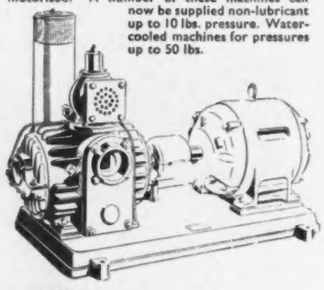

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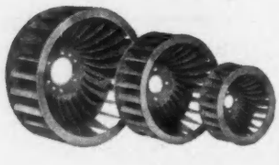

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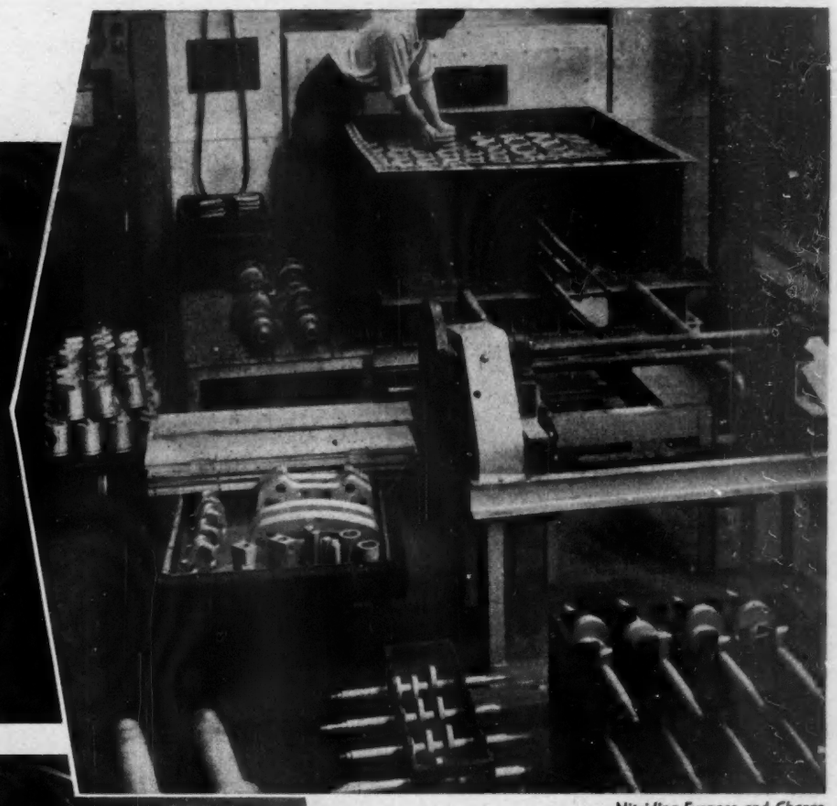

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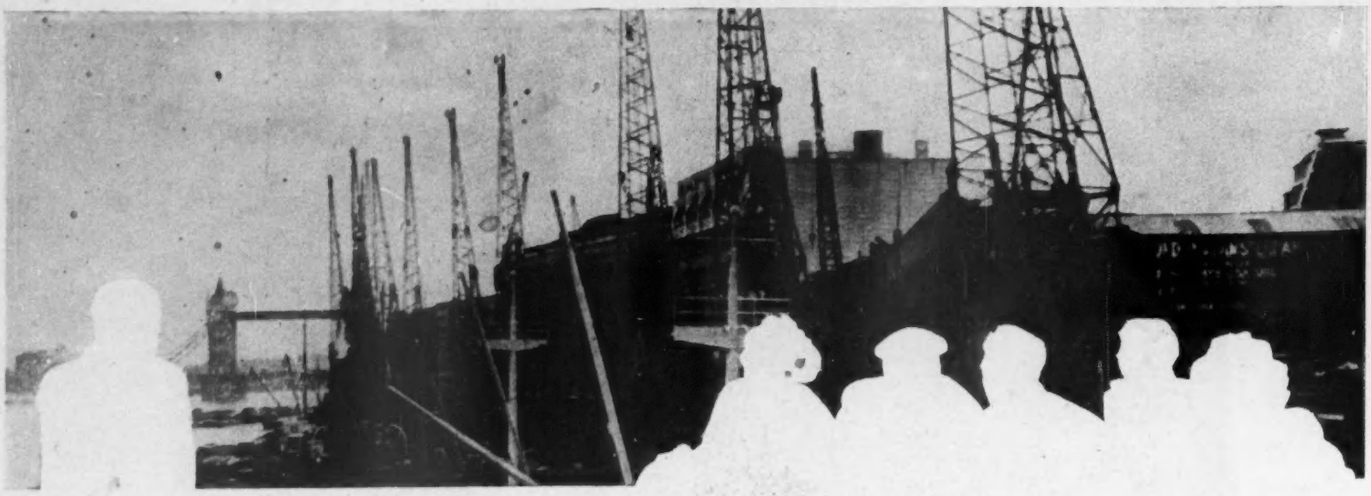

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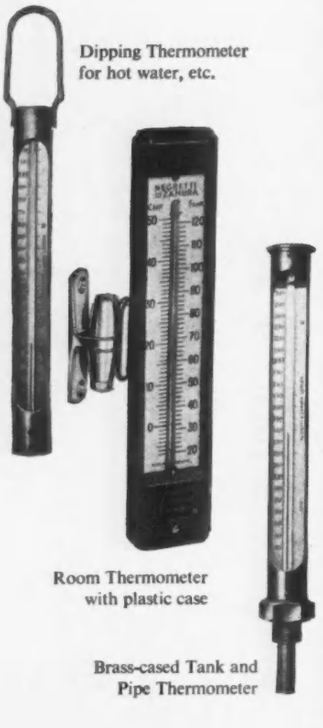

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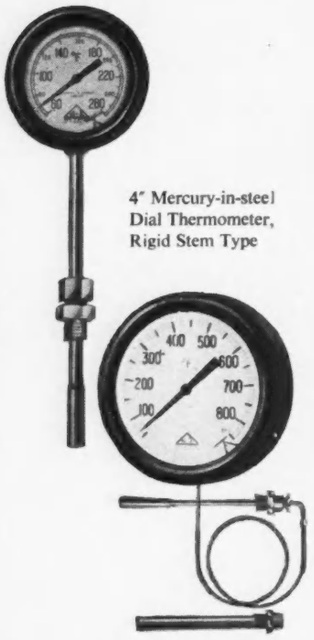

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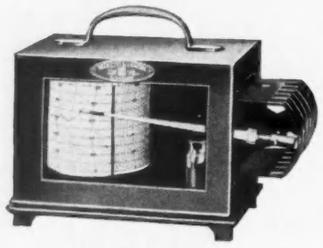

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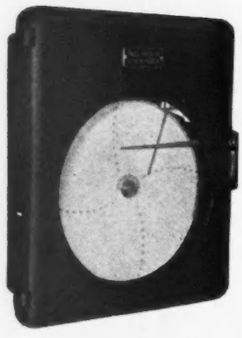

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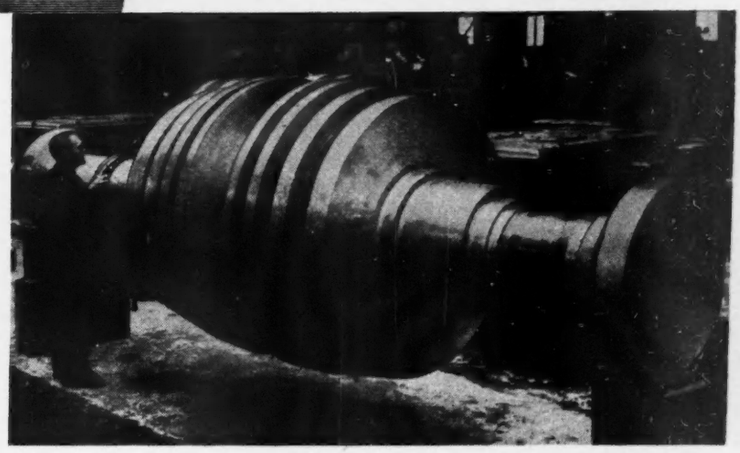
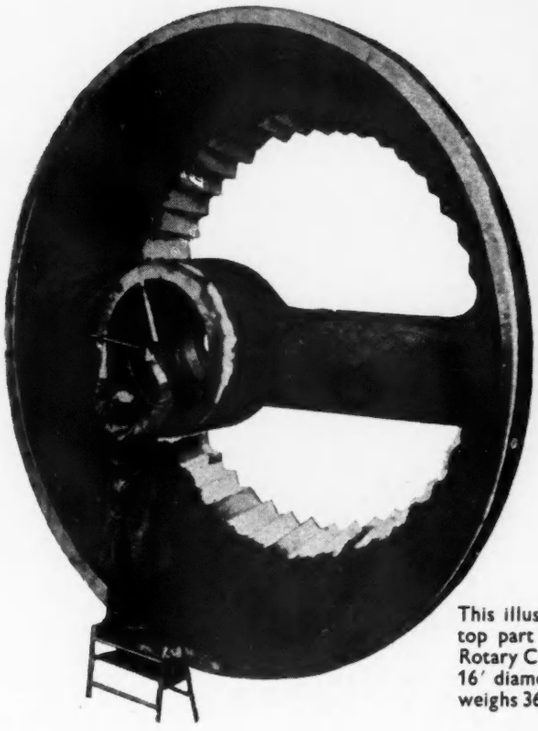


Shown above is a Forged Turbine Shaft of Nickel Chrome Molybdenum special steel rough turned and trepanned. This shaft for a Steam Turbine is 17′ long, the largest diameter 58″ and the smallest 14″, weight 19 tons.



This illustration shows the top part of the Shell for a Rotary Crusher in cast steel 16′ diameter and 7′ high it weighs 36 tons 3 cwt.

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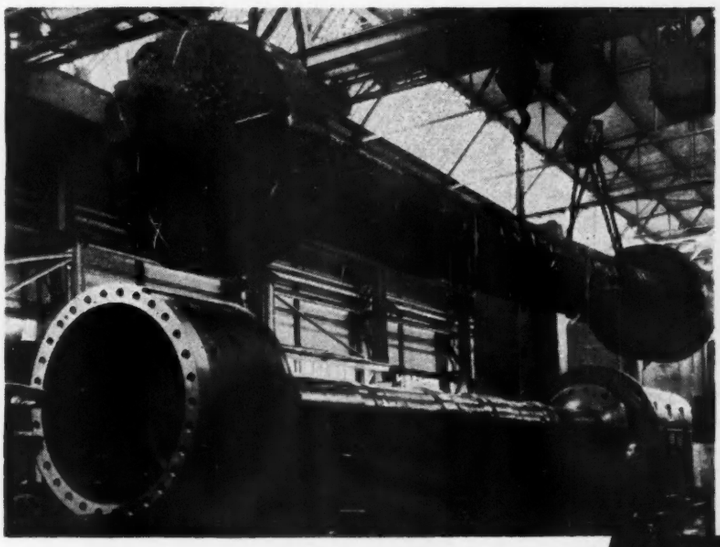

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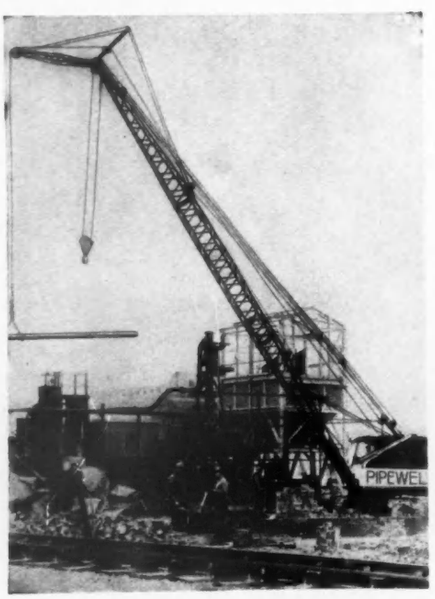

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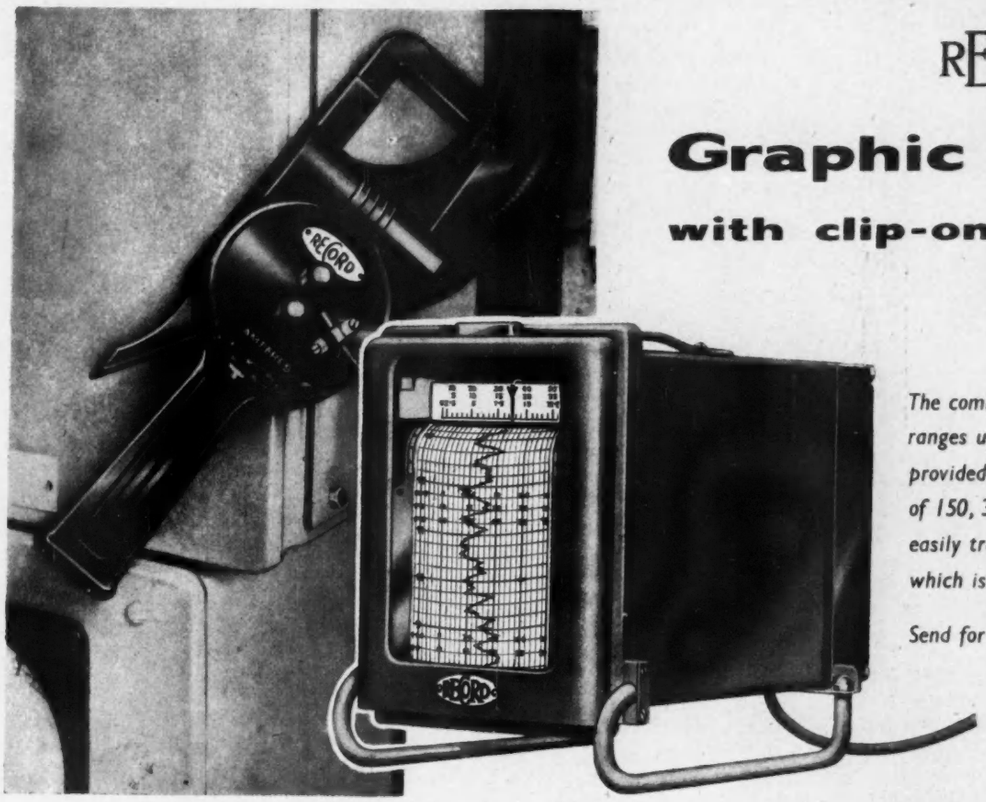

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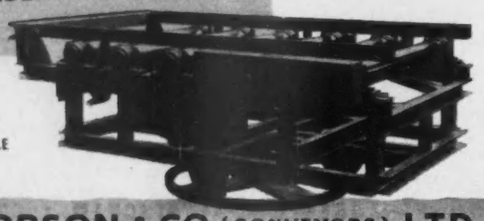

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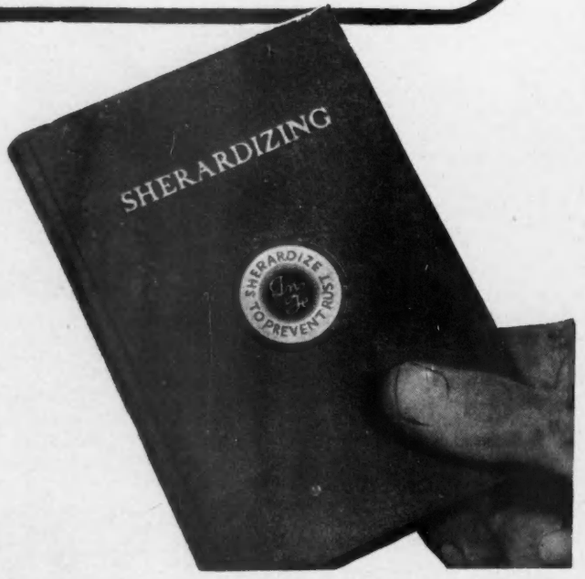

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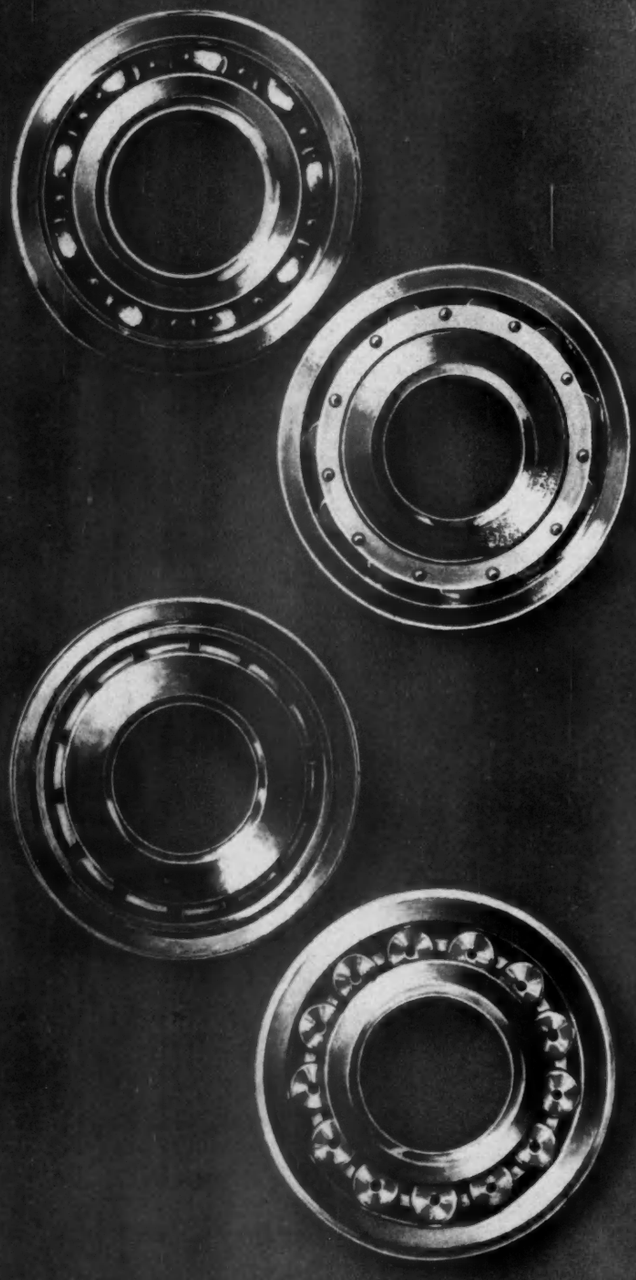

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THE ENGINEER

No. 5428 FEBRUARY 5, 1960 VOL. 209

RAILWAY WAGES

By the time these words appear in print it is just—but only just—possible to hope that the leaders of the National Union of Railwaymen will have had second thoughts and will have called off the official strike on the railways fixed to begin on February 15. For the decision of the executive committee to call for strike action does little credit to the intelligence of the men's leaders or of the men themselves. No one could benefit from such a strike, which could do nothing towards resolving the railway wage situation. The only thing it is likely to do is to destroy public sympathy with railwaymen without in the least altering the fact that railwaymen have a reasonably good case for improved rates of pay. The twice-rejected N.U.R. claim for a "substantial increase" in the wages of its members has not yet been considered by the Railway Staff National Tribunal and the N.U.R., with the other railway unions, is party to an agreement which precludes strike action until all stages of the negotiating machinery have failed. It is proper to bear that point in mind in any consideration of the existing dissatisfaction about railway wages. When Sir Brian Robertson, chairman of the British Transport Commission, met the leaders of the three railway unions last Friday, he could obviously not do much more than remind them of their agreement to await the findings of the Guillebaud committee which is examining the railway wage structure. The Commission has already promised, as soon as the committee's report is received, to negotiate an "interim increase" back-dated to January 11. Sir Brian pointed out to the union leaders last week that the Commission did not contend that a pay increase to railwaymen was not justified nor did it say that finance to meet an interim increase was not available. But he naturally emphasised the impossibility of departing from an agreement "at the request of one party to it only." That is not an unreasonable attitude and for the N.U.R. executive to claim that "it had no alternative" but to instruct all its members to withdraw their labour on February 15 is, to put it very mildly, most unhelpful. No doubt, the executive felt that its declaration would restrain the threatened unofficial strike action in the London area last Monday. In a large measure, it did, though the all-day stoppage on much of London's Underground, creating discomfort, delay and chaotic traffic conditions, undoubtedly alienated a good deal of public sympathy. One thing, however, seems fairly plain. It is that the three railway unions, although unwilling to criticise each other, are reluctant to agree on a common policy. British Railways are in the middle of a huge modernisation programme, upon the satisfactory completion of which their future depends. Has not the time arrived when the railwaymen's unions ought also to consider a modernisation programme? A helpful contribution to the future success of an important public service might be the creation of one union of railway employees instead of the continuation of three unions which evidently find it a little difficult to keep in step with each other.

EARTHWORK QUANTITIES FOR HIGHWAYS

At a recent Press visit we were shown how conveniently the two techniques of aerial surveying on the one hand, and computation with a digital computer on the other, can be combined to eliminate a great deal of arithmetical drudgery at a certain stage in the design of a highway. A system has been developed by Hunting Surveys, Ltd., in collaboration with Elliott Automation, Ltd., whereby earthwork quantities for a proposed highway can be calculated, simply by supplying data obtained with the customary plotting equipment direct from the photographs of an aerial survey of the line, into a digital computer. The data from the survey consists in effect of ground levels on cross sections at, say, 100ft intervals. The computer programme includes instructions on the proposed line and level of the new road, and a set of typical cross sections, of which there are twenty-seven. The machine is then capable of "choosing" the relevant cross section, i.e. whether "cut" or "fill," or whether the road is turning left or right, applicable at each chainage, and it disgorges, at the rate of 1 mile of road in twelve-and-a-half minutes, tabulated figures at each cross section of chainage, areas and volumes of cut and fill, running totals of cut and fill volumes, and "stake line" distances (i.e. the distance from the centre line to the toe of an embankment or the crest of a cutting) and heights of cut or fill at each shoulder. Compaction in embankments above a certain height is allowed for in the computation, by a simple rule.

To those familiar with computer programming, this application will hardly seem unusual. But it is, we think, worth while to draw the attention of the practising civil engineer to it, since savings in cost and probably in time, seem likely to be brought about by its use. Experimental surveys have been carried out and there seems to be no question that the method is accurate enough for its purpose. It also encourages greater flexibility in the choice of line of a new highway, for it is a simple matter to run off quantities for several alternative routes, an advantage which in some cases may in itself be enough to justify its use. The gradients and levels of a new road, even if its line is fixed by other considerations, may also be amenable to some adjustment in the design stage. Several highway engineers have questioned whether it might not prove economic to increase earthworks so as to flatten gradients, offsetting the earthwork costs against savings in fuel for the vehicles using the road. Such calculation is obviously more practicable and exact if it does not rely on tedious work in the drawing office. The same general method, combining aerial surveying with a computer programme, is also useful for the calculation of reservoir capacities and of quantities in stockpiles.

About a year ago we were able to record in these

columns the use of a computer service in detailing steel structures—a routine rather than a research task—and of course, other applications in structural engineering offer great possibilities. Thus in two fields, those of highway and structural design, practical use of these machines is being made by the civil engineer, with, in both cases, the flexibility and speed inherent in the elimination of oceans of arithmetic. Other applications —there are likely ones in hydraulic and traffic engineering—will doubtless follow on soon.

AN INTERNAL COMBUSTION ENGINE CENTENARY

To the student of technological history the year 1960 brings a notable centenary since it was in 1860 that the internal combustion engine can be said to have emerged from the experimental stage of its development, though two more years were to elapse before Beau de Rochas described the four-stroke cycle. On January 24, 1860, Joseph Etienne Lenoir received grant of French patent No. 43,624 : " Moteur à air dilaté par la combustion du gaz." The Lenoir engine, while by no means the first, is usually regarded as having been the first commercially successful gas engine, though it is true that in certain essential features—including the ignition—it closely resembled the gas engine constructed —but not patented—by James Robson in 1858–59. The earliest of Lenoir's engines were constructed in Paris during 1860 by Hippolyte Marinoni and engines subsequently built in accordance with Patent No. 43,624 by La Société des moteurs Lenoir (Gautier et Cie) Paris, were of double-acting horizontal type with crosshead and slot connecting rod, the mechanical design closely following contemporary horizontal steam engine practice. Like the rather earlier Robson engine, the Lenoir engine operated without compression and in its earliest form—as happened later in the case of the prototype Diesel engine—was not fitted with cooling jacket. Ignition was by battery and Ruhmkorff coil, a pair of electrodes being fitted at each end of the cylinder, these electrodes being connected to " a simple form of rotatory commutator fitted to the crank-shaft of the engine, and so arranged that the necessary make and break of contact should be produced at the right moment." In later engines (embodying modifications patented in 1861) the " rotatory commutator " was discarded, a reciprocating device being used. This consisted of a small metal frame bolted to the engine bedplate and having attached to it the negative wire of a Ruhmkorff coil, so that the whole of the working parts of the engine were earthed. The necessary mechanism for effecting the sequence of contacts was actuated by the piston-rod crosshead. Lenoir, after experiences with his first engines, " discovered that the admission of the air and gas in regular and alternate layers or strata inside the cylinder, was a very important feature in the obtainment of a proper and perfect combustion of the gas, and consequent expansion of the air. To ensure this result, M. Lenoir very considerably modified the form and general arrangement of the air and gas inlets and valves connected therewith."

The Lenoir gas engine rapidly achieved a considerable commercial success, many hundreds of them being manufactured and sold. The greater number were of 3 h.p., the earliest engines having a cylinder approximately 76mm (3in) bore by 143mm (5⅝in) stroke. Operating as it did without compression, the gas consumption of the Lenoir engine was high, the indicator thermal efficiency being no better than about 4 per cent. Not so well known as it should be is the fact that Lenoir gas engines were used—though the application was not commercially successful—for the propulsion of road vehicles and at least one marine application was made. It is further on record that a short flight was performed by a balloon rendered dirigible by a Lenoir gas engine, this being doubtless the first instance of the use of an internal combustion engine for aviation purposes. In Great Britain the Lenoir engine was manufactured by The Reading Ironworks Company, Ltd., Reading, and writing in 1909, Sir Dugald Clerk refers to a British-built Lenoir engine at Petworth as having worked as a pumping engine for twenty years and being still in good condition. It may be mentioned that the British patent (No. 335) for the Lenoir engine was applied for on February 8, 1860, by John Henry Johnson.

EXAMINATIONS IN TECHNICAL WRITING

We still have inflicted upon us only too frequently reports by public and semi-public bodies, catalogues and instruction books from manufacturing firms, and other examples of technical literature which reflect no credit upon those who created them. Often the English used is turgid, ambiguous and ungrammatical ; and illustrations are often crude when they are not downright misleading. However, there is now ground for hope that there will be a steady improvement in standards as the years roll by. For in May of this year, for the first time, examinations for an Ordinary Certificate in Technical Authorship are to be held as a consequence of the formulation by the City and Guilds of London Institute of a syllabus for technical authorship. So that teachers and candidates shall have some idea of the kinds of questions that may be set, the Institute's examiners have prepared some specimen questions. The actual examination will be divided into two parts, one of three hours' duration intended to test knowledge of the principles and practice of technical authorship, and the other of six hours' duration (in two three-hour periods) designed to test skill in technical writing and editing. Four years ago, it will be remembered, work was started by the Institute upon the formulation of a syllabus in technical illustration and examinations are now regularly held in that subject. Thus, as from May of this year, the Institute will be setting examinations and making awards in the two closely related subjects of technical writing and illustration.

A body which has been active behind the scenes in encouraging the Institute to start examinations in these subjects is the Technical Publications Association. It was set up some seven years ago, amongst other things " to promote the advancement and improvement of technical publications techniques by interchange of knowledge and information." To indicate its continuing interest in the examinations, that Association makes and intends to continue to make an award to the top candidate in each of the two subjects annually. Congratulations are certainly due to it and to the Institute upon the outcome of their work.

How soon will the leaven work ? It would, we think, be over-sanguine to expect very notable results very quickly if only because—alas !—there must be many men in quite senior positions, the men who authorise the printing of present poor quality material, who will continue to do that job and who will not have experienced the courses. Furthermore there is always the money aspect. It is not always easy to convince directors that the expenditure of more money upon a publication, as, for example, by engaging a competent man to illustrate it, will be really worth while. But as a consequence

of the work of the Association and the Institute it is possible to look forward confidently to a steady, even if rather a slow, improvement in standards.

IS THE M.T.T.A. TOUCHY?

We sympathise with the Machine Tools Trade Association. A statement from that body is printed on page 232 of this issue. We agree ; it is quite peculiarly irritating to any body such as the M.T.T.A. to suffer sharp criticism for failing to do something it is not in its power to do ! In the present instance the industry appears to have been criticised for failure to publish a D.S.I.R. report on research and development needs ; the Melman Report prepared by Professor Melman for the European Productivity Agency ; and a report by the National Production Advisory Council for Industry, believed to contain nothing not already published by the M.T.T.A. or already freely available for publication. It is, of course, obvious that the M.T.T.A. has no power to decide whether the reports of the two latter bodies shall be published. It has, however, welcomed the establishment of a sub-committee of the Machine Tool Advisory Council to examine Professor Melman's findings.

The D.S.I.R. report is in a somewhat different category. Though the genesis of the inquiry no doubt was " D.S.I.R's need to be provided with information on the research and development needs of industry as part of the background to their own programme," the machine tool industry co-operated heartily and it is a reasonable surmise that it is because of objections within the industry rather than within the Department that the report has not so far been published. One of the industry's objections is mentioned in the M.T.T.A. statement. It is that firms supplied confidential technical information valuable to competitors at home and abroad. The trouble, of course, is that critics of the industry are not likely to be reassured by that kind of statement which is just the kind of thing they would expect the Association to say if it was " covering up." The fact that there has been no publication of the report, of course, supports rumours that the report is very critical. In the circumstances is not the Association being a little touchy ? For non-publication of the report was bound to have the consequences it has had, particularly as it is known that the Association is formulating proposals for consideration by its members for further efforts in the research field, an action which supports suggestions that the report was, in fact, critical. This month there are to be a series of regional meetings to " crystallise " what is to be done. We do hope that after the meetings have been held the Association will be ready to publish at least some of the D.S.I.R. findings together with details of any actions the members are intending to take to meet its criticisms. For unless something is published no " statements " or " press releases " by the Association will put a stop to rumours and innuendoes. It is more likely that they will feed them !

ACCELERATION AND GRAVITATION

The Harwell experiments reported on page 231 of this issue, involving laboratory measurements bearing on Einstein's theory of relativity, are of academic rather than practical interest. The theoretical import of this work, its concept and its execution may be expected to appeal mainly to scientists. However, although there are no foreseeable commercial applications, engineers, too, will be interested. For the elegance of the experimental methods will win their admiration and the accuracy implied in the measurements will excite the incredulity and envy of practitioners who normally think in terms of a few tenths of a thou. and who occasionally aspire to surface finishes expressed in micro-inches !

In any assessment of the achievement of this young team of Harwell scientists—Cranshaw, Schiffer, Whitehead and Hay—one should bear in mind that these men " hope to repeat their measurements with greatly improved accuracy, in the next few months, in order to give added weight to their conclusions." So far, in one experiment they have measured the effect of the Earth's gravitational field on electromagnetic radiation consisting of gamma rays ; and in a second experiment they have compared the first set of measurements with the effects of accelerations on the same kind of radiations. If the results could be accepted as being conclusive they would constitute an experimental proof of Einstein's Principle of Equivalence, which postulates that there should be no detectable difference between acceleration and a uniform gravitational field. In the more discreet phraseology appropriate to the occasion it would be better to say that the combined results of the Harwell experiments are " not inconsistent with " the Principle of Equivalence.

This assumption is, of course, implicit in the inertial navigation systems used for guided missiles and it must now be accepted that acceleration is indeed indistinguishable from a uniform gravitational field; it will mean that the occupants of a space ship, with no means of external communication, will be unable to determine from any measurement made inside the space ship whether it is at rest in the gravitational field on the surface of a planet, or whether the ship is accelerating.

The Engineer—100 Years Ago (FEBRUARY 3, 1860

" THE METROPOLITAN UNDERGROUND RAILWAY "

" This scheme, which has been for so many years before the public, is at length in course of being carried into effect. Shafts are being sunk at several places along the line of the proposed railway. One has been opened on the unoccupied piece of land at King's-cross, near the railway station, and another near Euston-square. When a sufficient depth has been reached, the excavators will commence tunnelling in the direction of the London and North-Western Railway Station, with which a junction will be effected a short distance from the present terminus. At King's-cross a junction will also be made with the railway near the first bridge which crosses Maiden-lane. These side branches will, at the point of juncture, be on the level with the railways with which they communicate, but they will join the main or trunk line beneath the New-road, the gradients rising gradually from 25 ft. below the thoroughfare to the rails of the London and North-Western and the other line. . . .

" The underground railway will be provided at one or two places along the line, probably at those spots where the shafts are now being sunk, with ventilating shafts. But it is considered that there will not be any great necessity for providing ventilating shafts, as the numerous stations along the line and the cuttings at each end will provide sufficient currents of air for the purpose. The railway will be provided with two lines of rails, but they will be on the mixed gauge, and available for the carriage of the broad as well as of the narrow gauge, and the heavy goods traffic will be carried on during the night. The passenger carriages will be lighted with portable gas, and everything will be done to make a journey 25 ft. below the surface of the ground as pleasant and as comfortable as possible."

Obituary

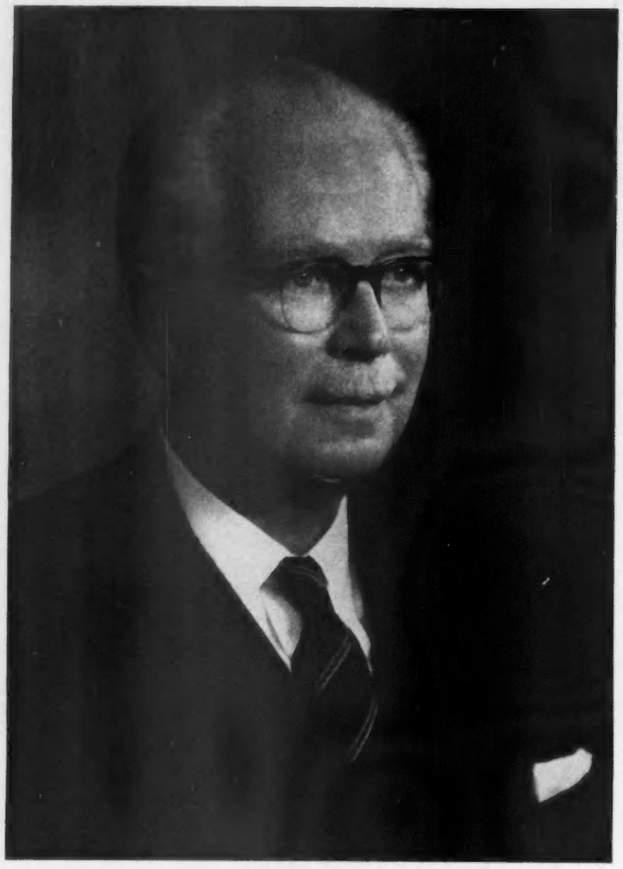
A. C. HARTLEY, C.B.E.

THE death of Mr. Arthur Clifford Hartley, which occurred in London on January 28, is deeply regretted throughout the engineering profession. His career was a notable one and he was one of the few engineers of recent times to become president both of the Institution of Civil Engineers and the Institution of Mechanical Engineers. Mr. Hartley had not, in fact, completed his year of office as president of the "Civils." He was seventy-one.

Mr. Hartley was born at Hull and was educated at Hymers College, the Hull Technical College and at the City and Guilds (Engineering) College. Having gained a B.Sc. (Engineering) degree, with honours, he spent two years in the North Eastern Railway docks office at Hull under the late T. M. Newell, the chief docks engineer. In 1912 he moved to Rose Downs and Thompson, Ltd., to extend his mechanical engineering experience and in the early part of 1914 he came to London to take up an appointment as works superintendent of Limmer and Trinidad Asphalt Company. There, as he said himself in later years, Mr. Hartley "gained experience in management of a process works and in the handling of men, as well as engineering experience in converting intermittent processes to continuous ones." As the first world war gathered momentum, however, Mr. Hartley was commissioned in the Royal Flying Corps and was selected to work with Professor Bertram Hopkinson in the Experimental Armaments Section of the Air Ministry. The most urgent requirement at that time was for a reliable gear to control a machine gun and enable it to fire between the propeller blades of fighter aircraft. The development work entailed in perfecting the Constantinesco gear for the purpose was described in Mr. Hartley's presidential address to the Institution of Mechanical Engineers in October, 1951.

When the war ended, Mr. Hartley joined the consulting engineering partnership of Maxted and Knott, concentrating mainly on the design and layout of cement works in this country and overseas. Mr. Hartley's next appointment, in 1924, marked the beginning of his long period of distinguished service to the oil industry. In that year he became assistant manager in the engineering department of the Anglo-Iranian (then the Anglo-Persian) Oil Company, Ltd., succeeding, in 1934, to the position of chief engineer. The company had been established for about fourteen years when Mr. Hartley first joined it and its annual oil production was rather less than 4,000,000 tons. Before he retired, in 1951, the annual output in Persia exceeded 30,000,000 tons and the company's interest in the Iraq and Kuwait Oil Companies had developed on an extensive scale.

Some of Mr. Hartley's best known work, however, was the outstanding contribution which he made to the nation's war effort between 1939 and 1945. In the early part of the war, he was seconded for service with the Ministry of Aircraft Production. There, he was associated with a team at the Royal Aircraft Establishment which was engaged in the development of a stabilised automatic bombsight. Subsequently, in 1942, preparations were being made for the Allied landings on the French coast and Mr. Hartley transferred to the Petroleum Warfare Department. One of the most important requirements was for a pipeline to supply petrol across the English Channel to ensure the successful advance of the Allied armies when the landings were effected. It was quickly realised, of course, that none of the usual methods for constructing a submarine pipeline could be employed because of tidal currents, the time factor and the certainty of enemy interference. The use of a number of small diameter flexible pipes was finally decided upon, the system being known as "Pluto" (pipeline under the ocean). This imaginative, and highly successful, operation was described in THE ENGINEER of May 25, June 1, 8 and 15, 1945. During the same period, Mr. Hartley was closely associated with other projects for the successful prosecution of the war. These included flame weapon development and the development of a method for clearing fog at airfields. The latter came to be known as "Fido" (fog, intensive, dispersal of); it was described in our issues of June 8, 15 and 22, 1945.



A. C. Hartley

After the war, Mr. Hartley resumed his work with the Anglo-Iranian Oil Company, Ltd., and in his remaining six years as chief engineer took an important part in the company's expansion schemes, particularly in the construction of large-diameter, long-distance pipelines. When Mr. Hartley retired from the Anglo-Iranian in 1951, he engaged in private practice as a consultant and latterly had been a consultant for Rendel, Palmer and Tritton. One of his most recent achievements was the designing of "Hoister" equipment for the offshore loading of oil tankers. A detailed description of the equipment was printed in our issue of October 2, 1959. A "Hoister" equipment was installed by the Kuwait Oil Company, Ltd., at Mina-al-Ahmadi and began operation early last year, loading tankers of up to 65,000 tons anchored in 55ft of water at L.W.O.S.T. where there is a rise in tide of 11ft.

We have made brief mention of Mr. Hartley's presidency of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. He was elected to associate membership of the "Civils" in 1916, transferred to full membership in 1928 and had served on the council since 1946, taking the presidential chair at the beginning of the current session. He became an associate member of the "Mechanicals" in 1916, transferring to full membership in 1927 and succeeding to the presidency in 1951. His presidential addresses to both Institutions effectively surveyed the varied aspects of his interesting career as an engineer. But, above all, they emphasised that "very few urgent engineering problems cannot be solved provided they are clearly defined and are tackled from a background of sound knowledge and wide experience." Mr. Hartley was also an honorary Fellow of the Imperial College, a vice-president of the Institute of Petroleum and a member of council of the Royal Society of Arts. He was appointed C.B.E. in 1944 and received the United States Medal of Freedom in recognition of his work on "Fido." Among his many other qualities, Mr. Hartley was an able writer. We have been privileged to include in our pages several articles from his pen.

Much of Mr. Hartley's success in life undoubtedly stemmed from a charm of manner which everyone meeting him for the first time quickly felt. But those who knew him more intimately discovered under the charm a very firm and determined character. Once his mind was made up on any subject it took a very good argument to shake his convictions; for the very simple reason that in making up his mind he was accustomed to study any matter very thoroughly. By contrast, during the process of making up his mind he wanted to probe other people's thoughts. He would listen to, comment upon, or challenge any argument presented to his notice. In such a phase he was easy to talk with. He had also a capacity for taking more pains than most men allied to that invaluable quality, enthusiasm. Such imaginative and novel solutions to particular problems as "Pluto" and "Fido" would never have been given the breath of life had not his enthusiasm urged on the work of development. Above all, he had faith. As the sentence of his that we quote above shows, he was confident, not only of his own abilities, but also of the abilities of engineers in general, to serve mankind.

Sea Transport of Liquid Methane

THOMAS LOWE GRAY LECTURE

By Dr. JOHN J. McMULLEN, B.S., M.S.*

Here we reprint a substantial extract from the thirty-second Thomas Lowe Gray lecture presented to the Institution of Mechanical Engineers on Wednesday of last week, January 27. The author first explains why there is an increasing interest in the possibility of utilising more natural gas as fuel than at present and reviews the sources of natural gas. The physical and chemical properties of various gases are then studied, leading to the conclusion that storage at low temperatures is desirable. The metallurgical properties of materials at low temperatures are considered and also liquefaction systems. The extracts conclude with some studies of designs for special seagoing craft for carrying methane and other gases.

THROUGH the centuries, progress and industrial development have caused the world to continually seek more economical types of energy. It is ironical that many of the most highly developed and civilised areas of the world are dependent upon the isolated and remote areas of the world for some portion of the energy which they require in the conduct of their industry and living. Since the end of the 1939–45 war (World War II), one of the greatest surges in the field of transportation has been the movement of fossil fuels from areas in the Middle East, South America, Far East and the United States. Since 1945, we have seen the conventional oil tanker increase, not only in number but also in size, until, at the present time, tankers of 100,000 tons deadweight or more are being constructed for the transportation of oil. One of the interesting points in this tremendous acceleration in the field of marine transportation has been the fact that it has been proven cheaper to move the oil in large ocean-going ships than by any other means. This takes into consideration pipelines, rail and tank car transportation. The results of this increase in the field of marine transportation is evident and well known to all. Admittedly, the technical and political difficulties and geographic impossibilities have all contributed to the more favourable economics of marine transportation. This has been evidenced by the two-and-one-half-fold increase in the world's tanker development since the end of the 1939–45 war.

It is, therefore, interesting to contemplate what will happen during the next decade in marine transportation. There will be, unquestionably, an ever-increasing demand for the utilisation of large ocean-going tankers, but at the same time, a great increase will take place in the transport of gases by ship. Certainly, the number of ships engaged in this trade ten years from now will not exceed the number of conventional oil tankers, but, on the other hand, the increase in this particular area will be significant. It can be visualised that, within the next ten years, we shall see, either under construction or actually in operation, some fifty ocean-going gas carriers. The commencement of this stage of development has already started, and at the present time there are ships carrying all forms of gases, including liquid methane, propane and butane. These initial developments have been inspired and instigated by the demand for lower-cost energy in one form or another.

It also becomes obvious, from a purely practical standpoint, that as time goes by, maximum utilisation of available forms of energy must be made because of the ever-increasing demand, production and cost. For example, in the United States, in order to maintain a realistic reserve production ratio, at least one and one-half barrels of oil must be discovered for each barrel produced. Since this has not been accomplished, the projected use of gas and/or other forms of energy, must make up the difference. Furthermore, as the use of gas increases, its cost to the consumer decreases and this also tends to make the projected utilisation of gas even higher.

In reviewing the possible sources for gas, the world can be divided into five general areas : namely : (1) North America ; (2) South America ; (3) Middle East ; (4) North Africa, and (5) European Continent. At the present time, these areas, excluding the Soviet bloc, represent the known sources of gas in one form or another.

In the United States, there is no question but that the use and potential of gas has only begun to be felt, in spite of the fact that during 1959 the amount of energy obtained from natural gas exceeded that of heating-oils for the first time. The natural gas industry has increased far faster than ever anticipated and, at the present time, it is conceivable that the pipelines which are now criss-crossing the United States from Texas to the north-east and the north-west are operating practically at peak capacity. It is apparent that, once the existing pipelines in the United States reach peak capacity on a summer-demand basis and the use of gas continues to increase, it is possible that a portion of the required increase can be carried via sea, in ships and/or barges. In 1958, the total monthly sales of gas during the peak demand of the winter month of February was approximately 8910 million therms, while during July, the demand was only 4827 million therms. It is this tremendous variation which necessitates the consideration of natural gas storage by utilities in either a gaseous or liquid state. Gaseous storage requires tremendous volumes and the use of underground reservoirs, which in certain areas are not available. The volumetric ratio of gas to liquid for methane is 630. Ethylene and propane ratios are slightly less, being 485 and 316 respectively. It is for this reason that, in the United States, increasing consideration is being given to liquefaction of natural gas and storage in the liquid state. This tends to make the transport by sea more attractive.

It is conceivable that gases will be piped to a port of loading, liquefied and transported to a central point in the north-eastern or north-western part of the United States, stored and then regasified for distribution. One of the great advantages which do exist in the United States, in addition to the ever-increasing market for natural gas, is the presence of known gas wells in their basic form. Naturally, a great deal of the gas is available as a by-product from the oil wells already in operation, but none the less the mass of the gas (two-thirds) produced and utilised in the United States comes from gas wells.

The gas situation in South America, and particularly in Venezuela, is the opposite of that in the United States. In Venezuela, the present known gas reserves are in connection with oil wells and, where the gas is not reinjected for pressure purposes, it is flared off. It is this practice of reinjection which can cause the availability and price of gas from Venezuela to fluctuate. It is the opinion of several large oil companies that the gas is worth more from an economic or political standpoint if it is reinjected. However, in 1958, 56·33 per cent, or 627,019 million cubic feet of Venezuelan gas was flared. The utilisation of Venezuelan gas increased from 35·55 per cent in 1957 to 43·67 per cent in 1958. Of the latter, 8·48 per cent was burnt as fuel ; 3·99 per cent was sold for use in Venezuela ; 29·55 per cent was reinjected, and 1·65 per cent was processed for natural gasoline. It is interesting to note that the utilisation for all purposes is increasing. If the time should come when all the gas is saleable, even that used for reinjection can be considered owing to the possibility of utilising water injection.

Therefore, we will assume that gas is available in Venezuela and further assume that, as the demand does increase, it is quite possible that more emphasis will be placed on the exploration for true gas wells. One of the great advantages of Venezuela is the proximity of the gas to the sea and the possibility of minimum pipelines and transportation costs overland.

Coming to the Middle East, it is noted that practically all of the known gas will be a result of a by-product from the oil wells presently under exploration and production. One of the relative disadvantages of the Middle East is the fact that the area is quite remote from the possible consumers and this, combined with the loading problem, makes the Middle East a least likely area of development for gas. However, this will depend entirely on what happens to the basic cost of the gas in the other areas. If, for reasons beyond control, the price of the gas at the source increases considerably in one area, it will tend to force the movement or purchase of the gas from another source. Saudi Arabia has, at the present time, approximately 60,000 million cubic feet per year of gas available for sale. This amount apparently represents approximately 34 per cent of total gas production which is being flared off.

One of the areas which appears to be the most likely and available for development of gas is northern Africa. At the present time, there are vast known gas reserves (about 17,000,000 cubic feet) and it is quite likely that, owing to the proximity to Continental Europe and Great Britain, the first great movement of gas may be from northern Africa. Here, however, the problem seems to be that the gas reserves are remote from the sea and will require extensive and expensive pipelines for movement to sea ports. However, pipelines are already under construction from Hassi R'Mel to Algiers and Oran.

In all areas, except North America and

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Continental Europe, the known gas reserves have resulted coincidentally with oil exploration. As the demand for gas increases and emphasis is placed on gas exploration, the reserves and their location will certainly become greater and better situated from a geographic standpoint. For example, during the 1930s in the United States, it was assumed that the gas/oil ratio would continue to be about 2250 cubic feet of gas discovered per barrel of oil. Actually, at the present time, the discovery ratio is about 7000/1. At present, in Venezuela, where gas is not being sought, the discovery ratio is 1150 cubic feet per barrel of oil. It can be assumed that this will increase roughly three or four times as gas is explored.

In so far as the European Continent is concerned, the gas will be consumed locally and piped. This development will be similar to that which has taken place in the United States.

While the above areas represent possible sources for the gas, it is also important to consider the areas for consumption. As already mentioned, the United States is being converted to natural gas on a very high scale. This has resulted in the construction and operation of many pipelines which are now honeycombing the entire country. However, the United States is unique in that it is not only the consumer, but also the producer of the gas. For this reason, it is an internal situation which results in a rather high price for the gas at the source, but since the transportation problem, via either pipeline or the sea, is a relatively simple one, the gas is available to the consumer at a very competitive price. The other three areas which are most available for development of natural gas are the United Kingdom, Northern Europe and Japan. Naturally, there will be many other minor areas, such as Italy, which will have developments of their own and which will obtain the gas from the best possible sources, both locally and abroad. However, the United States, United Kingdom, Northern Europe and Japan will represent the largest users of gas in one form or another. These basic considerations tend to indicate that, as previously mentioned, the factors of transporting these gases via the sea will certainly develop tremendously during the next decade. Since the United Kingdom and Japan are highly industrialised and populated insular countries, it is apparent that importation of gas will be via the sea.

TABLE I—*Heat Values of Representative Manufactured and Natural Gases*

	B.Th.U./cubic foot of gas at 60 deg. Fah. and at a pressure of 30in mercury		
	High	—	Low
Blast furnace gas	93	—	92
Blue water gas	310	—	285
Carburated water gas	578	—	529
Coal gas	634	—	560
Coke oven gas	536	—	476
Natural gas :			
Follansbee, W. Virginia	2221	—	1970
McKean Co., Pennsylvania	1482	—	1350
Wash Co., Oklahoma	1125	—	1064
L.A. Co., California	1123	—	1053
Sandusky, Ohio	1047	—	946
Navarro Co., Texas	1044	—	988
Novata, Oklahoma	1014	—	959
Tarrant Co., Texas	738	—	698
Natural gas residual :			
Follansbee, W. Virginia	1868	—	1711
Oil gas	516	—	461
Producer gas	136	—	128
Fire damp (coal field methane) :		Average	
Point of Ayr colliery	—	955	—
Lorraine	—	472	—
Hainault	—	955	—
Saar (cracked and mixed)	540	—	—

Table I gives the heat values of representative manufactured and natural gases, and Table II, which has been compiled from many sources, gives the approximate physical and chemical properties of many common gases, including air. One of the most striking properties of gas, particularly methane, is that the relative volume of liquid (at boiling point) to gas (at 70 deg. Fah.) is very great, or 630 in the case of methane. This is what makes liquefaction very attractive. However, the liquefied gas is still very light or about 26 lb per cubic foot for methane compared to 64 lb per cubic foot for seawater or 61·5 lb per cubic foot Bunker " C." This makes the size of storage vessels or ships relatively large when compared to the storage vessels or ships for other liquids.

Liquefaction of gas can be accomplished with the aid of pressure, the higher the pressure, the higher the boiling point. For example, normal butane can be liquefied at 100 deg. Fah. if the pressure is raised to 37 lb per square inch gauge and propane can be liquefied at 100 deg. Fah. if a pressure of 175 lb per square inch gauge is employed. However, no matter how high a pressure is exerted on it, methane cannot be kept in a liquid state if its temperature exceeds −116 deg. Fah. or 148 deg. of frost. Therefore, it may be seen, that if methane is to be stored under great pressure and a low temperature of −116 deg. Fah., the resultant mechanical and refrigeration problems are far greater than if the methane is stored at atmospheric pressure and −259 deg. Fah. In the case of the other hydrocarbon gases such as propane and butane the temperatures are relatively not far from ambient, so that storage is normally under pressure with only slight refrigeration necessary.

Physical and Chemical Properties of Liquid Methane

One of the very great advantages of methane as a domestic fuel as compared to propane, butane or manufactured gas is that it is lighter than air, allowing it to rise in the atmosphere and reduce explosive dangers. Natural gas is also non-toxic as compared to manufactured gas, making loss of life possible only by suffocation.

But safeguards must be provided in the storage of such a cold liquid as liquid methane. The heat of vaporisation of such a liquid is far higher than most liquid gases, meaning that a relatively high amount of heat must be provided to vaporise the liquid. When the No. 4 tank in Cleveland ruptured in October, 1944, the dynamic on-rush of 935,000 imperial gallons of liquid quickly overran a low dyke (equivalent in volume to the volume of the tank), then spread into the immediately adjacent laboratories, plant, and residential areas. The frigid liquid rapidly ran down adjacent streets, into sewers, &c., freezing everything in its path and subsequently vaporised and exploded with flames rising half-a-mile in the air. The resultant loss of life was 128 persons and the property damage exceeded 6,000,000 dollars. Therefore, in any shore or ship installation, adequate safeguards must be made to contain the liquid in the event of tank or system failure.

Metallurgical Properties of Materials at Low Temperatures

The containment of a liquefied gas such as methane requires great skill on the part of the designing engineer and the fabricator, in that the materials employed and methods of construction are concerned with an extremely cold liquid which, if released, would become a highly dangerous flammable gas.

Many materials, including all metals, show an increase in strength properties such as hardness, fatigue limit and elastic limit as temperature is decreased. However, certain metals, particularly most steels (carbon and low-alloy), chromium, tungsten, molybdenum, vanadium, &c. (some of which are quite hard and brittle in commercially pure form) crystallise in a body-centred cubic lattice structure. This means that, by the recommended Charpy Impact Test, within a rather narrow temperature range these materials change from being ductile or " tough " to being very brittle at lower temperature.

In the containment of any cold liquid, particularly in a ship where vibration and hydrodynamic shocks are present, it is essential that the material remain ductile. As a matter of note, the United States

TABLE II—*Approximate Physical*

	Methane	Ethylene	Propane	Butane	Ethane
Molecular formula	CH_4	C_2H_4	C_3H_8	C_4H_{10}	C_2H_6
Molecular weight	16·04	28·05	44·09	58·12	30·07
Specific heat, B.Th.U./lb/deg. Fah.	at −175 deg. = 0·4502 at −112 deg. = 0·5308 at 59 deg. = 0·5284 50 deg.–392 deg. = 0·5931 —	at −131·8 = 0·3086 at 59 deg. = 0·3592 59 deg.–212 deg. = 0·399 77 deg.–392 deg. = 0·430 —	— — — — — —	— — — — — —	— at −115·6 deg. = 0·3475 at 59 deg. = 0·3861 — —
Boiling point, deg. Fah.	−258·7	−155·2	−43·87	+31·1–31·6	−128·2
Melting point, deg. Fah.	−299·2	−273·1	−309·82	−211	−297·8
Liquid density, atm. pressure lb/ft³	25·908 — —	at −161·6 deg. = 35·335 at −5·8 deg. = 25·596 at +50 deg. = 13·110	— 36·35 —	— 37·5 —	— 34·087 —
Vapour density, sp. gr., air = 1	0·5544	0·9749	1·554	2·0854	1·0493
Heat of vaporisation, B.Th.U./lb	— — 248·4 —	— — — —	— at 68 deg. = 150·12 at 32 deg. = 161·28 at −22 deg. = 176·40	— — 164·7 —	at 32 deg. = 135·0 at −4 deg. = 156·6 at −40 deg. = 175·5 at −130 deg. = 228·6
Inflammable limit in air, per cent :					
Upper	5·00	2·75	2·12	1·86	3·00
Lower	15·00	28·6	9·35	8·41	12·50
Relative volumes as liquids at boiling point and gas at 70 deg. Fah.	630	485	316	108	488

Bureau of Mines report on the disastrous fire at the Cleveland L.S.R. (Liquefaction, Storage, Regasification) plant indicated that the culprit was the No. 4 storage tank made of 3½ per cent nickel steel which failed in a brittle fracture probably augmented by seismic shock from an adjacent railroad area. It must be noted here that this disaster was only caused by the storage tank failure coupled with insufficient dyke work and storage location. This was not a failure of the system of process of Liquid Gas Storage.

A group of metals which do not change in ductility or toughness as temperature is decreased are those single-phase metals that crystallise in a face-centred cubic lattice structure. Metals which fall in this category are copper, silver-brazing metal, cupro-nickel alloy, aluminium and certain of its alloys, gold, nickel, lead, platinum and the austenitic and stainless steels. Of the latter, a recent publication has indicated that for low temperature use 2¼ per cent nickel steel be used down to −75 deg. Fah., 3½ per cent nickel steel to −155 deg. Fah., 9 per cent nickel steel down to −320 deg. Fah., and 304 types and 304L stainless steel down to −452 deg. Fah. It is recommended that, although almost any of the United States 5000 series of aluminium alloys can be used, the toughest, 5456 aluminium, would probably be the best for low-temperature use.

Naturally, once a particular metal were selected for the containment vessel and associated piping, very meticulous design, fabrication procedures, inspection, and testing would be required.

Of course, in the case of the other hydrocarbon gases, liquefaction is not necessarily the only way of containment. Pressurisation is also possible, and the metallurgical properties of a metal containment vessel are then less influenced by low temperature than by ordinary mechanical requirements.

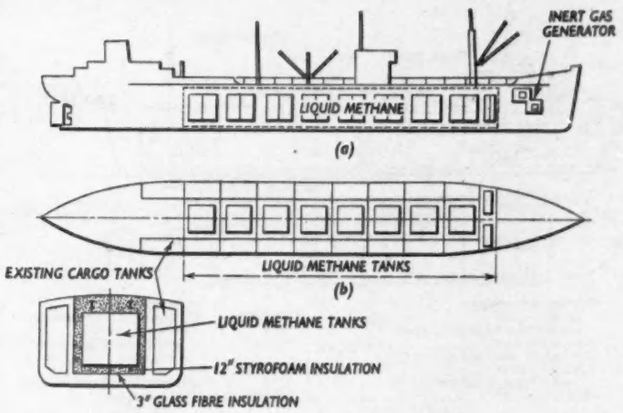
Methane Liquefaction Systems

There are many systems presently available for the liquefaction of gas. Original development in the field was started many years ago in the liquefaction of air by Linde with the subsequent separation of oxygen. The system Linde utilised was the Joule-Thompson effect whereby gas is compressed, precooled and expanded to the temperature at which it is liquefied.

An expansion system which develops external work was developed by Armongood and Claude. This is apparently a refinement of the Linde system where an expansion engine such as a turbine is employed to further cool the gas before final expansion to liquid. The work accomplished by the engine can be employed in the system.

A third practical system for liquefaction is the cascade process such as that used in the Cleveland L.S.R. plant. This system normally consists of two or three closed expansion cycles in series operation at different temperature levels. Different refrigerants are employed with successively lower boiling points with the cooling effect being obtained by expansion of the higher boiling fluids successively liquefying compressed fluid in the next stages.

With previous experience gained in the liquefaction of other gases and that gained in the successful liquefaction of methane in the Cleveland L.S.R. plant, Moscon L.S.R. plant and Morrison's natural gas-liquefaction barge, there is no doubt that this portion of any operation would present no unusual problems. Before any liquefaction system were selected, a review of existing systems and newly proposed systems, such as those for Chicago or the one proposed by Crecca, should all be investigated. Operating cost and capital investment and return would provide the key to the system selected and extent of refinement to be employed for any given plant efficiency factor.



Length overall	523ft 6in
Length between perpendiculars	503ft
Breadth (moulded)	68ft
Depth (moulded)	39ft 3in
Present lightship	5252 L.T.
Converted lightship	6023 L.T.
Service deadweight	2110 L.T.
Methane deadweight	1710 L.T.
Cargo oil deadweight	9620 L.T.
New load displacement	19,463 tons
New load draught	27ft 2in

Proposed—not built.

Fig. 1—The "J. D. Crecca," L.M. tanker design

Methane and Special Tanker Designs

I think it will be of some interest to describe some of the special liquid bulk carrier designs that have been accomplished, to illustrate the rapidity with which ship design is advancing.

I will start with a proposal which was prepared in the United States of America. The standard tanker in the United States is still the T-2 as built during World War II. However, this type of tanker has generally reached an age which requires major overhauls and costly repairs. For this reason, many of these ships are rebuilt using the afterbody, the engine plant, and foreship only. Therefore, it is understandable that this type of existing ship was chosen for the conversion to a combined natural gas-oil carrier. There were three possible choices for liquid methane carriers. First, a converted dry cargo ship : second, a converted tanker ; and third, a newly constructed special-type tanker. The decision was made in favour of the existing T-2 tanker. It is well known that a ship constructed for a specific use is usually cheaper in the long run than a converted vessel. However, with respect to lack of experience in the transportation of liquid gases, the capital risk in a conversion was evaluated as reduced to a minimum.

In this conversion, which was carried out only on paper by J. D. Crecca, special tanks were housed in rooms made out of the eight centre and two smaller forward cargo tanks. The overall carrying capacity amounted to 147,200 cubic feet of liquid methane at −258 deg. Fah. and atmospheric pressure. A new double bottom in the base of the old cargo tanks and installed below the new methane tanks provided, together with the original wing tanks, space for 9620 tons of oil cargo. The estimated price for this limited conversion during 1955 was 3,600,000 dollars. The typical arrangement used in this ship is shown in Fig. 1.

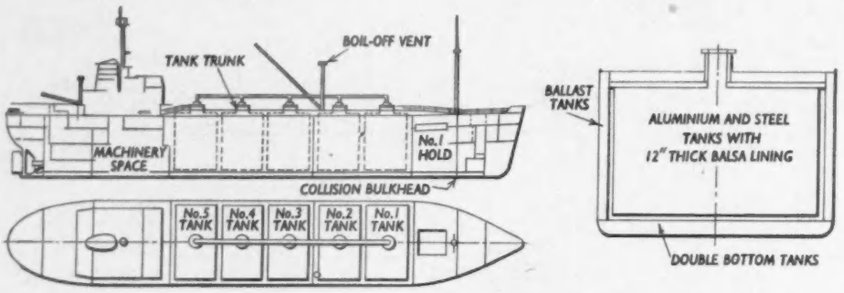
Basically the same idea was used in the conversion of the "Methane Pioneer"

Properties of Gases

Hydrogen disulphide	CO_2	Nitrogen	Helium	Argon	Air	Oxygen
H_2S	CO_2	N_2	He	A	—	O_2
34·08	44·01	28·02	4·003	39·94	29·0	32·00
— at −70·6 deg.=0·292 at −49 deg.=0·279 at 59 deg.=0·2533 50 deg./374 deg.=0·243	— — at −103 deg.=0·184 at 59 deg.=0·1989 —	— — at −293·8 deg.=0·256 at 59 deg.=0·2477 —	— — at 64·4 deg.=1·25 — —	— — at −292 deg.=0·133 at 59 deg.=0·1253 —	at 212 deg.=0·2404 at 752 deg.=0·2430 at 1832 deg.=0·2570 at 2552 deg.=0·2699 at 3272 deg.=0·2850	— — 0·218 — —
−79·6	−109·3	−320·8	−452·2	−302·8	−127·3	−297·3
−117·4	−69·7	−345·9	−458·0	−308·2	−227·6	−361·5
— 53·670	— at −76 deg.=74·292 at +68 deg.=48·071	— 50·194	— 7·616	— 88·026	— 57·436	— at −297 deg.=71·2 at −320 deg.=75·1
1·190	1·529	0·9672	0·138	1·3796	1·00	1·103
— 237·42 — —	— at −76 deg.=156·96 at −22 deg.=128·52 at 32 deg.=99·0 at 86 deg.=21·42	— 85·68 — —	— 10·8 — —	— 67·68 — —	— 91·75 — —	— 91·6 — —
4·30 45·50	— —	— —	— —	— —	— —	— —
—	58	690	755	—	760	856

which is the first of its type and is presently being operated on an experimental basis. The general layout for this design is shown in Fig. 2.

Although due credit must be given to the foresight and fortitude of the developers of the present experimental liquid methane ship and its auxiliary shore-side facilities which have been based primarily on the experience gained in the Morrison liquefaction and transport barges constructed in 1954, it is apparent that technological and developmental advances have already superseded their work. For example, the use of balsa wood insulation in the storage tanks may limit the insulation life to eight years and the method of ship construction is dependent on the desires of the regulatory bodies.



Original dimensions :	
Length overall	338ft 8½in
Length between perpendiculars	320ft
Breadth (moulded)	50ft
Dimensions after conversion :	
Length overall	338ft 8½in
Length between perpendiculars	320ft
Depth (moulded)	29ft 4in
Draught (moulded)	18ft
Deadweight (approximate)	5100 L.T.
Main propulsion	Diesel
Depth to upper deck in way of tanks	41ft
Horsepower	1700 at 180 r.p.m.
Service speed (approximate)	9 knots
Design draught	15ft 6in

Fig. 2—Liquid methane carrier M.V. "Methane Pioneer"

At present, more advanced tank and insulation design are being developed locally here, in the United States of America and elsewhere.

Going to the description of some other specially constructed ships, I would like to start with the wine tanker "Angelo Petri," California, owned by one of the world's principal wine producers. The ship can hold approximately 2,500,000 gallons of wine in its twenty-six cargo tanks. In addition it is capable of carrying over 1,200,000 gallons of lubricating oil in fourteen ballast tanks which are completely isolated from the cargo tanks.

The stern section is the surviving half of a T-2 tanker that came apart in a storm off the Alaskan coast in 1946. When bow and midships went to the bottom, the stern section was salvaged and towed to Anchorage, Alaska. There it served as a source of municipal electric power for several years until it was purchased by United Vintners, Inc., and Petri Wine Company of California early in 1956. Towed to the San Francisco yards of Bethlehem Pacific Coast Steel Corporation, the half-hull was destined to be transformed into something new in maritime history.

In arrangement of machinery spaces, dry-cargo spaces, and location of the midship and after-houses, the vessel resembles a conventional tanker. But the details of the cargo tanks and pumping arrangement distinguish this vessel from the ordinary tanker. The liquid food products are carried in twenty-six stainless steel clad tanks (ranging from 31,000 to 211,000 gallons). In addition to being isolated from each other, the cargo tanks are separated from the shell and deck and also from the wing tanks by 3ft wide cofferdams. These cofferdams are interconnected. They constitute a safeguard against bulkhead or shell-seam leakage of oil or salt water into the food cargo. The cofferdams are enlarged at their lower reaches between adjoining tanks to provide pump rooms—one for each of the eleven cargo pumps.

Because air has an adverse effect on wine and other liquid food products, the vessel's tank and pumping systems were designed to prevent air access.

The cargo tanks were constructed of plate, clad with type 316 chromium-nickel stainless steel. The percentage composition of type 316 stainless steel is 16–20 chromium, 10–14 nickel, and 1·75–2·75 molybdenum. This alloy has excellent resistance to corrosion caused by mild acids encountered in food products.

The total cost for this special wine tanker amounted to about 9,000,000 dollars. The majority of this cost was due to the large extent of stainless steel, and not only for the tanks but also for pipes and valves. Again it is shown that even extremely high cost for a special design can be, in particular circumstances, proven to be very economical.

I brought up this particular example with the intent of showing you the price range which must be expected as soon as it is required to use high-quality steel for special tanks.

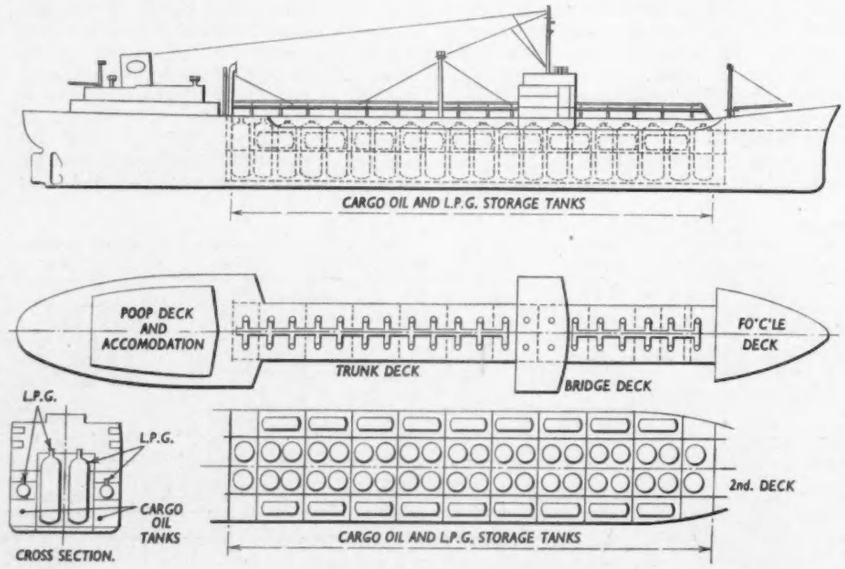
As mentioned elsewhere in this paper, aluminium has been already very successfully used for gas tankers instead of stainless steel. The cost for aluminium tanks including insulation is about in the same range as stainless steel tanks without insulation.

Rapid developments have been made in the transport of L.P.G. by water, both inland and overseas. L.P.G., or liquid petroleum gas, is a hydrocarbon mixture either in liquid or gaseous form. The main components are propane, butane, propylene, iso-butane, butylene or mixture thereof in any ratio or with air. It is used throughout the United States of America for various industrial and domestic gas applications.

Total sales of liquefied petroleum gas in liquid form during 1958 amounted to 7·59 billion gallons, equivalent to an increase of 9·4 per cent from the level one year earlier. Domestic and commercial use of 3·53 billion gallons represented 46·6 per cent of the 1958 total, and were 15·2 per cent higher than in 1957.

The largest L.P.G. carrier in service is the "Esso Puerto Rico," ordered from Cantieri Riuniti dell'Adriatico, specially designed by the technical staff of the Esso Shipping Company as a combination liquefied petroleum gas bulk-oil carrier. The general arrangement is shown in Fig. 3. The space available for bulk oil is 1,186,000 square feet and the fifty-eight cylindrical liquefied petroleum gas tanks have a total L.P.G. capacity of 450,100 cubic feet. The tanks and attendant systems are designed for an L.P.G. pressure of 150 lb per square inch and the loading and unloading system consists of two identical groups installed in separate pump rooms. Each consists of two turbine-driven liquefied gas-handling centrifugal pumps and all other auxiliaries. All pumps are steam driven. The unloading is performed by "over-pressurising" the liquid in the cylinders and forcing the liquid through pipelines to the suction side of the liquefied gas-handling pumps.

Several controlled valves are installed for the isolation of the tanks. The valves can be operated from a number of central points

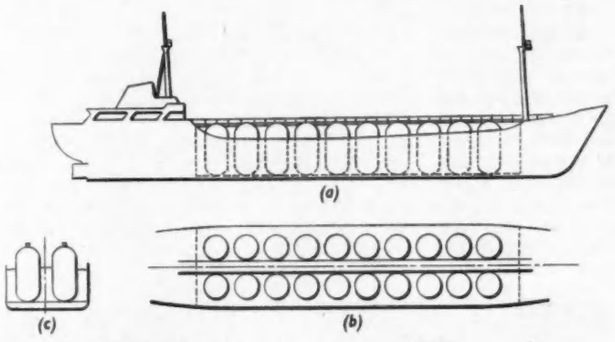


Length overall	690ft 9in
Length between perpendiculars	660ft
Breadth (moulded)	89ft 9in
Depth (moulded) to upper deck	47ft
Speed	17 knots
Cargo space for bulk oil	1,186,080 cubic feet
Total L.P.G. cargo	451,345 cubic feet
Deadweight tonnage	32,300 tons
Displacement	48,940 tons

Fig. 3—Turbine-driven tanker "Esso Puerto Rico," combination L.P.G./oil

in the case of emergency. One ventilation system is provided for collecting any vapour leaking from any place in the pipe or tank system. Cargo-handling for the oil is in agreement with normal practice.

Another ship which I would like to mention, because of the unique form of the gas tanks, is the motor ship "Agipas Terza," built in Italy for the Societa Nazionale Azienda Metanodotti, Genoa, and constructed for the transport of L.P.G. The general arrangement is shown in Fig. 4.



Length overall	262ft 6in
Breadth (moulded)	35ft 5in
Depth (moulded)	18ft
Draught (loaded)	14ft 2½in
Gross tonnage	1386 tons
Speed	13·8 knots

(a) Profile. (b) Deck plan. c) Cross-section.

Fig. 4—Motor vessel "Agipas Terza," L.P.G. carrier

Eighteen cylindrical hemispherically bottomed tanks are located in the hull of the vessel with the tops protruding above the main deck. The total capacity of the tanks is 1730 cubic metres, and the normal service pressure is 256 lb per square inch.

Connections for gas and liquid lines for vaporisation and for safety and drain valves are arranged at the top of each tank. The gas and liquid line connections are again hydraulically operated from a central control system similar to the design of the "Esso Puerto Rico."

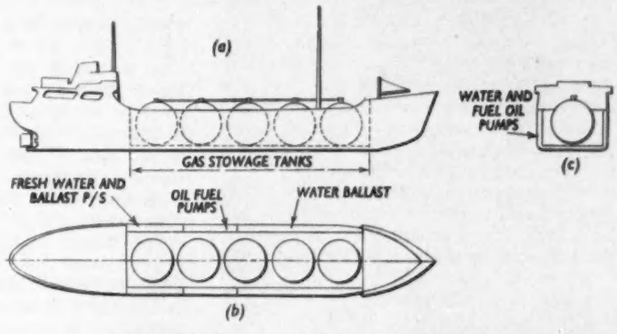
The "Signe Tholstrup" went one step further in the curvature of the tanks. It was built in Denmark, for a Dutch owner, using five spherical containers which could hold a total of 275 tons of gas. The ship is shown in Fig. 5. A second shelter-decker with a carrying capacity of 445 tons of butane in five spherical containers is still under construction. The spherical containers are of all-welded construction and are connected water-tight to the shelter-deck. All pipes carrying gas are mounted outside the compartment in which the tanks are present. Cargo-handling is effected by two compressors and a pump, all driven by independent air-cooled diesel engines.

A combination of cylindrical tanks is installed in the "Natalie O. Warren" (Fig. 6). She represents one of the first built ocean-going tankships designed to transport propane or other liquefied gases under extremely high pressure. She was converted from a Cl-A cargo-type ship for the Warren Petroleum Company. The ship's cargo is carried in sixty-eight special high-tensile steel tanks capable of withstanding pressures in excess of 250 lb per square inch. Two outboard rows consisting of thirty-one tanks, are below the top deck and are equipped with 24in "necks" or manholes which extend through the deck to make the necessary connections. The ship's capacity is some 33,000 barrels or 1,386,000 gallons.

A complete ventilating system changes the air in all holds in thirty minutes. Six 500–800 gallons per minute turbine-driven centrifugal pumps discharge the cargo, and a 1300 h.p. turbine-driven centrifugal compressor forces the liquefied petroleum gas to the pumps.

As one of the first vessels of this type ever built it is clear that extremely careful security measures were taken. A complete combustible gas-detector system also has been installed. It will sound an alarm if a gas-air mixture, anywhere in the ship, reaches only 40 per cent of the lower explosive limit. A complete carbon dioxide system, capable of instantly flooding any hold or the engine-room has been installed, and the ship's original smoke-detecting equipment has been reinstalled. These security measures can be considered to-day as standard on all similar ships.

In conclusion, it can be seen from the given examples that the first step in the direction of the transportation of liquefied gas was taken very carefully and appears to be "snowballing" at the present time.



Length overall	195ft 7in
Breadth (moulded)	28ft 6in
Depth to upper deck	16ft 11in
Draught	9ft 10½in
Gross tonnage	399 tons
Deadweight tonnage	450 tons
Speed (loaded)	10½–11 knots

(a) Profile. (b) Second deck. (c) Cross-section.

Fig. 5—"Signe Tholstrup," liquefied butane carrier

Conversion of Existing Vessels

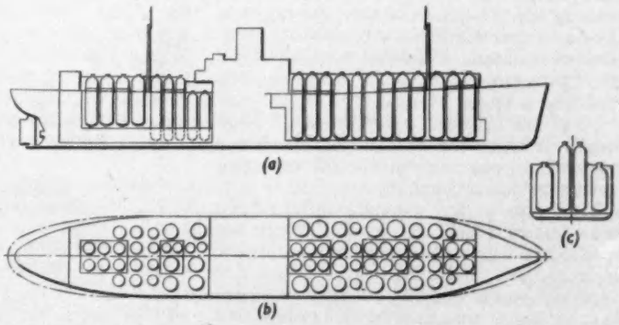
A proposal by John D. Crecca in 1955 envisaged the conversion of a T2-SE-A1 oil tanker to a liquid methane carrier. His conversion was of a simple type retaining as much of the original hull as possible and utilising the cargo space between the existing longitudinal bulkheads for methane, the outboard wing tanks being employed for cargo oil.

The "Methane Pioneer" experimental liquid methane tanker is an operating conversion of the Cl-M-AV1 machinery-aft, small, dry-cargo ship. This conversion essentially consisted of "gutting" the inside of the present holds by eliminating all decks, and building integral steel and aluminium, insulated rectangular tanks, covered by a new, raised main deck.

Many of the original L.P.G. carriers were converted cargo ships although the more recent L.P.G. vessels have been designed and built new for the purpose.

This leads one to believe that in a new trial of a unique shipping problem, such as the carriage of liquid methane, where the cost of the structure and equipment is relatively high in comparison to the machinery cost, the most reasonable economic approach could be accomplished with a new ship. There are, of course, many T2-SE-A1 vessels afloat and serious consideration has been given to conversions due to the present depression in the bulk-oil trade. Combined with the fact that many of these vessels are due for their third or fourth special classification survey with resulting extensive and expensive structural renewals, they are either being "jumboised" as tankers (if the trade is available), converted to more profitable trades, or simply laid up. In most cases the existing machinery plant is in very good condition, making this an ideal ship for conversion purposes, but as stated above the cost saving in a liquid methane conversion would be nominal.

Since the structural mid-bodies of the T-2 in most cases are no longer suitable for the carriage of oil, unless great expenditures are made, it has behoved oil operators to build new and of larger dimension mid-bodies for insertion between the present bow and stern. Conversions which can employ the present mid-body are to dry cargo or bulk carriers.



Length between perpendiculars	390ft
Breadth (moulded)	60ft
Depth at side (moulded)	37ft 6in
Draught, keel (summer)	24ft 6¼in
Displacement	11,625 tons
Deadweight	5,308 tons
Gross tonnage	7,299 tons
Net tonnage	5,096 tons
Propulsion	Steam turbine
Shaft horsepower	4,400
Sea speed	14 knots
L.P.G. cargo	38,053 barrels

(a) Profile. (b) Deck plan. (c) Cross-section.

Fig. 6—"Natalie O. Warren," L.P.G. carrier

In connection with liquid methane, with a density half that of water, a T-2 tanker could be severed to retain the bow and stern, and a new, specially constructed mid-body fitted which could give the ship a length, between perpendiculars, of about 625ft, a a beam of about 80ft, a depth of about 70ft, which conceivably could carry 14,000 long tons of methane, or the equivalent of about 760 million cubic feet of natural gas (or roughly 28,600 long tons coal or 20,400 long tons crude oil on a thermal basis). At the present time some saving could be effected by resorting to such a conversion due to the depressed prices for the T-2 tanker and the fairly low prevailing shipyard rates for steel fabrication. It is estimated that almost one-fifth of the price of a new vessel of equivalent capacity could be saved in this manner. Of course, against this feature should be weighed the fact that the hull and outfitting equipment is extremely expensive, compared to ordinary tanker equipment, which, in the case of a conversion, must be amortised in about half the ordinary life of a new vessel.

Conclusions

It is evident that as the highly industrialised nations expand their production and population, the consumption and demand of energy fuel will increase. Unfortunately the nations in Northern Europe and Japan do not have the natural resources for the fuel with which this energy is to be produced. Therefore, greater and greater importations of economic fuels become necessary. Natural gas, a clean and desirable fuel, because of the vast quantities available and presently being wasted is destined to become one of the primary sources of energy.

Liquefaction and storage of natural gas is a proven operation. The transportation of natural gas by-products by ship, such as L.P.G., has already become a commercial fact and the carriage of liquid natural gas, though experimental at the present time, is already a *fait accompli*. Designs for large methane-carrying vessels are already on the drawing boards and detailed studies are being completed for the most applicable trade routes.

Like any totally new type of ship, developmental work for this complicated class of vessel requires a great deal more time and effort relative to existing normal types. However, the concept has been proven and many of the interested parties who have been waiting for the result of this test are now moving ahead with definite projects. Experience of operation will count very heavily in any operation of this sort and experience is basically a factor of time.

New building for a specific application would produce the best end-result, but a conversion may have a limited economic advantage for a beginning.

Traditionally the shipping industry has been lethargic and conservative, which has resulted in feast-and-famine, bust-and-boom building and operating cycles. Such an approach to the building of liquid methane tankers may well prove disastrous, but this could easily happen if everyone sat back, waited for two or three parties to conclusively prove the large revenues obtainable and then all climbed on the bandwagon at once. Crash programmes do nothing more than inflate the cost of normal developments.

For these reasons I recommend that those parties who have been interested in the economically attractive transportation of natural gas, now move ahead with the required development work.

Developments in Silicon Devices

Semiconductor production by Ferranti, Ltd., is concentrated exclusively on silicon devices and extensive use is made of diffusion techniques. The following article describes some of the current activities of the company's Gem Mill works at Oldham and the research laboratories at Wythenshawe, with special reference to a new mesa transistor of which production is beginning this month, and which is claimed to be the highest-frequency transistor manufactured and marketed in the United Kingdom.

THE introduction of a silicon transistor of mesa form for oscillator, amplifier and switching applications at frequencies up to 100 Mc/s was made the occasion last week of a general display of semiconductor developments at the Gem Mill (Oldham) works and Wythenshawe research laboratories of Ferranti, Ltd., Hollinwood, Lancs.

At Gem Mill, the works area is 230,000 square feet and 650 people are employed. All the devices made are silicon. The first to be produced was the ZS30 series double-ended diffusion diode, which is particularly suitable for mounting on printed circuit boards and is being used widely in the aircraft industry. Final assembly takes place on the automatic plant described in our January 8 issue, page 61. The range of Ferranti diodes has now entered the high power class with the ZR40 high-current rectifiers rated at 100A. With forced air cooling at 600 linear feet per minute, the rating will exceed 170A. Examples were shown of these devices mounted on heat sinks in the form in which they are to be supplied for high-voltage a.c. motor coaches on British Railways and for locomotives in India.

The silicon mesa transistor which was the principal subject of the demonstrations is the ZT20. With the diffusion technique employed at Gem Mill the junction is formed right inside the silicon and is protected from expansion troubles (high-temperature working as well as high frequency was an objective of the transistor design). This is achieved by the application and

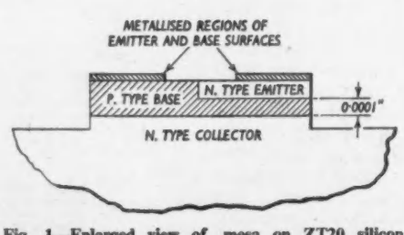


Fig. 1—Enlarged view of mesa on ZT20 silicon transistor

further development of the technique known as "diffusion" introduced by the Bell Telephone Laboratories, U.S.A., in which slices of single crystal silicon are heated at high temperatures in the presence of suitable chemical gas mixtures. The chemical composition of the gases is designed to introduce the appropriate chemical impurities into the silicon to form the required transistor structure just below the surface. All the major device dimensions are very small; a typical base thickness is 0·0001in, and collector diameter 0·01in, and it is from these characteristics, together with the close control of penetration obtained with the diffusion process, that the mesa derives its high-frequency performance.

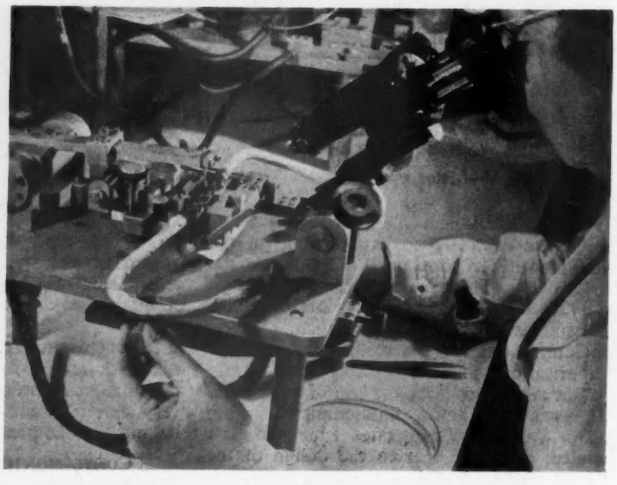


Fig. 2—Thermocompression bonding device for attachment of base and emitter wires

Several successive diffusions are, in fact, carried out by a process known as "mask diffusion," the result of which is the formation across the slice of a series of n-type phosphorus-diffused emitter stripes in the p-type base region which has been gallium diffused into the original n-type single-crystal starting material. By etching and masking a mesa formation is produced which enables 100 transistors to be made from a single slice of silicon 1in in diameter. An enlarged view of a mesa (named from the Mexican word for a flat-topped mountain) is shown in Fig. 1. Here the metallised regions of the emitter and base regions will be noted and it will be seen that direct contact with the base region is possible, enabling reliable electrical contacts with low base lead resistances to be produced. All the critical regions of the transistor are contained within the mesa, which is 0·002in high and 0·01in in diameter.

In making a transistor, a mesa dice obtained from the diffused disc is mounted on an expansion-matched nickel iron tab by a gold alloying process, and gold wires with a diameter of 0·001in are attached to the emitter and base regions by means of a thermocompression bonding process specially developed at the works (Fig. 2). These two connections, together with that to the collector region via the tab are seen in the

view of a completed transistor before encapsulation (Fig. 3) showing the tab and wires attached to a standard form of transistor header. The assembly is etched, coated with a surface-protecting varnish and hermetically sealed in a purified gas by means of a projection welding process.

A further application of mesa geometry was seen in parametric (variable-capacitance) diodes for applications in parametric amplifiers and for frequency modulation or remote

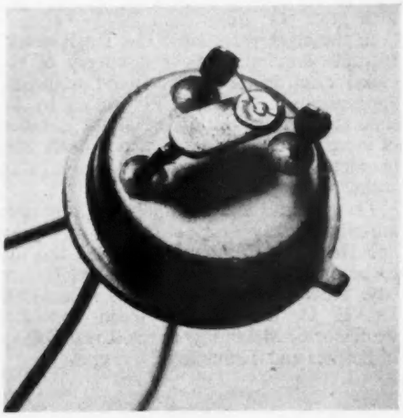


Fig. 3—A ZT 20 transistor before encapsulation, showing collection area on tab, with mesa containing base and emitter regions formed upon it

tuning control. The construction of such a diode is seen in Fig. 4. A parametric diode is a p-n junction semiconductor diode designed for low loss at high frequencies. Its capacitance depends upon the voltage across the junction. Any p-n junction diode has a non-linear capacitance-voltage characteristic. However, for use at high frequencies the loss must be greatly reduced from that obtained with normal diodes. This is achieved by having a small area junction but a base material of much larger area. The junction is formed by diffusing boron into n-type silicon. After cutting into dice a small mesa approximately 0·002in diameter is cut ultrasonically to reduce the capacitance.

Two parametric amplifiers for operation at microwave frequencies of interest in radio astronomy were exhibited, both making use of the variable reactance properties of these diodes to amplify the signal without introducing the cathode noise inherent in valve amplifiers.

The properties of single-crystal silicon with a p–n junction are also used in Ferranti solar batteries and photocells. In this form of photovoltaic cell the p–n junction is situated a very small distance (approximately 0·0001in) below the surface of the single-crystal plate, which is arranged to have as large an area as possible facing the incident light. When light falls on the cell, it penetrates a small distance below the surface of the silicon and releases pairs of positive and negative charge carriers which are separated by the built-in potential gradient at the p–n junction. A connection is made to each side of the p–n junction, to enable the current carriers so produced to perform useful work in an external circuit. Cells of this type were first produced some years ago at Bell Telephone Laboratories in America, and when used as sources for the conversion of solar energy to electrical power, they form the most efficient power source yet known. Efficiencies of the order of 10 per cent in optimum load conditions for the conversion of light energy to electrical energy are fairly readily achieved.

These cells (Fig. 5) were first made at Ferranti, Ltd., to act as photo-sensitive devices in tape and card readers, and the range has now been extended to include cells suitable for power generation, industrial control and instrumentation. Experimental installations are under test for trickle-charging the batteries of marine buoys and of telephone links. A typical assembly shown would provide an output of 2V at 250mA in bright sunlight.

Work seen when we visited the Wythenshawe laboratories included the development of four-layer devices using diffusion techniques to give switching times of 10–15 millimicroseconds. These consist of alternate p and n layers, 2 microns deep, and their characteristics may be controlled by making contact with one of the inner layers and feeding current via this control or gate electrode. Application of impulsive signals to the gate will change the device from the high to the low impedance mode similarly to the effect already well known in silicon controlled power rectifiers.

The two devices shown were an audio-frequency and a high-frequency four-layer triode. In the former the starting material is p-type silicon with n-type regions diffused in each surface. Three wires are alloyed into dice cut from slices of this material, and after a sequence of etching operations zones of p- and n-type silicon are regrown at the bases of the wires so that the desired four - layer cross - sectional structure is obtained. This audio-frequency device is expected to find wide application for replacing transistors in low-voltage circuits, replacing mechanical relays and switches, generating high-voltage pulses, and for inclusion in mixed thermionic/semiconductor circuits.

Development of the high-frequency four-layer triode is still in its early stages. The object is to produce a device with a switching

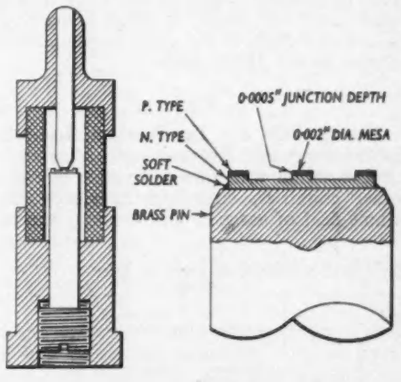


Fig. 4—Variable capacitance diode, showing active element enlarged on the right

time of the order of 10 millimicroseconds and a triple diffusion process is being followed in order to achieve the very narrow inner regions required. When fully developed, this device will possess a mesa-type structure and, because of the two advantages of high trigger voltage and low sustaining voltage, it is expected to fill a considerable gap that now exists in the field of semiconductor devices with respect to high-frequency, high-power devices.

Silicon of extremely high purity for use in special devices and in development work is produced at Wythenshawe by the hydrogen reduction of silicon tetrachloride on a hot tantalum filament, followed by further purification by the float zone process. The float zone equipment will handle bars 12in long and ¾in diameter. At present it can be used for work in a gas atmosphere only, but work on an internal coil vacuum system is under way. In another laboratory a zone refining equipment enables the silicon bar to be refined under vacuum or gas by an external r.f. coil system. The gas atmosphere used is argon plus 5 per cent hydrogen, both being purified to an oxygen content of less than

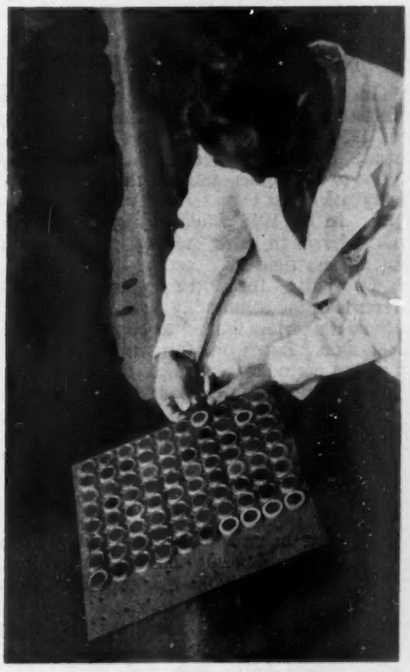


Fig. 5—Testing a solar battery assembly

5 p.p.m. and a very low moisture content. This equipment is powered by a 1 Mc/s, 5kW high kVA induction heater.

With the development of semiconductor devices, the tolerances on various material parameters are being tightened and various techniques are in use for correcting the orientation of the crystallographic planes with respect to the lapped or etched surface of the silicon slice, which is particularly important in mixed alloy, diffused devices. An X-ray production method for this purpose which was developed and designed at Wythenshawe involves simply reflecting an X-ray beam from the crystal plane on to a geiger counting tube and moving the crystal on a goniometer table to obtain maximum pick-up on the tube, the tube being set at the appropriate Bragg angle to the crystal and X-ray beam. This method involves no specimen preparation and the complete operation takes three minutes per specimen with an accuracy of a few minutes of arc.

WOVEN WEBBING FREIGHT NETS.—A freight net recently developed by Thomas French and Sons, Ltd., Chester Road, Manchester, is built up from woven nylon webbing slotted at intervals to permit the interposition of transverse lengths of webbing of similar construction. The slots are integrally woven into the webbing in such a manner that there is no reduction of strength in their area. The nets are stated to be strong, light, immune to rotting and the action of sea-water, highly abrasion resistant and compact. The three standard sizes of net available are 8ft, 12ft and 14ft square, weighing respectively 17 lb, 26 lb, and 28½ lb, but the construction of the slotted tape lends itself to the making of special purpose nets of many sizes and shapes. The nets can be supplied in a variety of colours, as a means of identification or to differentiate between sizes and capacities.

MAINLY METALLURGY

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

Non-Ferrous Metals in 1959

In the January 1, 1960, issue of THE ENGINEER outstanding metallurgical events of 1959 were considered and the available space limited us to ferrous metals. Turning now to the other side of the picture one may ask what non-ferrous metals were in use. In his 1958 *Dictionary of Metallurgy*, Dr. Merriman listed the physical properties of no less than fifty metals.

To judge from the morning papers' reports of the commodity markets one would think the metals limited to copper, tin, lead, and zinc. But if one turns to the specialist weekly periodical intended for those who work in the metal industry, lists of prices may be found for upwards of thirty primary non-ferrous metal ingots. In addition, it gives the prices of many standard alloys and recognised varieties of scrap metals.

The alloys may be made from virgin metals or from so-called secondary metals ; the former being smelted from natural ores and the latter being almost identical in chemical composition but produced from the treatment of scrap metals.

Prices are furthermore given for many semi-fabricated products, such as sheet, strip, circles, plate, wire, and tubes ; such prices vary of course according to dimensions and quantities.

As the main users of the established metals and alloys, and as potential users of metals and alloys now becoming commercially available, engineers and designers must consider their availability, prices and properties. Table I may help to that end by placing the most used metals in groups, arranged in order of price where that is available.

In column (1) are listed the well-known metals, which are readily available and sold in such large quantities that they are priced per ton. In column (2) are listed other metals, some of which are used in relatively large quantities for alloying with the more common tonnage metals, but as the metals listed in this column are less common they are priced by industry in pounds. In column (3) are listed the so-called precious metals of the platinum group with gold and silver ; all of them so relatively costly that industry prices them per ounce.

To simplify the picture let this table have only those three columns, but one may find lanthanum, the commonest and most basic of the metals of the rare earth group, quoted in the unit also used for germanium as 15s. per gramme. Mercury, as the only common metal which is liquid at ordinary temperatures, is quoted as £72 per flask.

Technical literature is nowadays replete with references to the results of State-aided researches into the properties of the "nuclear" metals, uranium and thorium, and of the metals which interest the designers of supersonic aircraft and rockets, such as titanium, zirconium and beryllium. Of these only titanium billets had become quoted in December, 1959, as may be seen in Table I. However, beryllium had become well established as an alloying element for copper strip, rod and wire, and towards the end of 1959 it had arrived as an exciting novelty in the form of sheets and tubes of the almost pure metal, which were extremely costly and not yet commercially priceable.

From these figures it is clear that the non-ferrous metals of interest to most users in 1959 were those priced by industry in tons, and listed in column (1) of Table I. It is fortunate for the users that at least eight of these metals are now well served by the regular issue of reliable technical information. It was not until 1926 that the present most helpful series of abstract services, Bureaus of Information, and Development Associations, commenced to become available to potential users of the most widely used metals and alloys. It is here convenient to consider them in the order in which they appear in the above table.

TABLE I—*Non-Ferrous Metals in Use in* 1959, *Listed in Descending Order of Price*

Per ton	£	Per pound	£ s. d.	Per ounce	£ s. d.
Tin	794	Cerium	16 0 0	Rhodium	41 0 0
Nickel	600	Calcium	2 0 0	Platinum	28 0 0
Arsenic	400	Molybdenum	1 10 0	Iridium	24 0 0
Manganese	245	Tellurium	18 0	Ruthenium	18 0 0
Copper	240	Bismuth	16 0	Gold	12 10 1½
Antimony	197	Cobalt	14 0	Palladium	8 0 0
Aluminium	180	Cadmium	9 6	Indium	10 0
Zinc	91	Chromium	6 11	Silver	6 8½
Lead	71	Magnesium	2 0	Osmium	—
Silicon	—	Selenium	—	Osmiridium	—
	(1)	Titanium (Billet)	2 15 0		(3)
		Tungsten	—		
			(2)		

TIN

During 1959 the Tin Research Institute headquarters and laboratories in Middlesex, in association with their colleagues in eight other countries, continued to survey the whole field of usage of tin, its alloys and its compounds. Their quarterly journal, *Tin and its Uses*, recorded much that was of value and some items which were of more than technical interest, such, for example, as the fact that 1959 was the centenary of "Big Ben." (Bell metal is a tin rich bronze.)

Inestimable millions have benefited from the widespread developments which followed the production of the first tinned food just over 150 years ago. Partly for that reason tin continued to be used more widely, even if through the great expansion in the electrolytic coating of tinplate more thinly, in the storage of foodstuffs, despite its relatively high price per ton.

In the eight years since the Tin Research Institute announced their discovery of tin-nickel electroplate it has found numerous applications in industry. Produced by the simultaneous deposition of equal numbers of atoms of tin and nickel it is a hard, non-magnetic, and corrosion resistant alloy surfacing for steel.

Tin research and metallurgical education are now closely linked. Only a few years ago Dr. J. W. Cuthbertson left the Institute to become Professor in Nottingham University. Now in 1959 another of its valued staff, Dr. E. C. Ellwood, has been appointed Professor of Metallurgy in the Royal College of Science and Technology, Glasgow.

NICKEL

Ever since the two largest producers of nickel joined forces thirty-four years ago, and set up a bureau of information on nickel in each of the countries most likely to use that metal and its alloys, abstracts of current published information have continued to be issued in a monthly summary entitled *The Nickel Bulletin*.

In recent years this has been supplemented by specialist booklets on Wiggin nickel alloys, of admirable authority and clarity. Herein one may read, for example, how nickel alloys behave in contact with hydrochloric acid, hydrogen chloride and chlorine or, from another booklet in this series, how the alloys behave in caustic alkalies.

Still another source of information on the now very numerous and successful alloys of nickel which cannot fail to interest all engineers is the technical journal of Henry Wiggin and Co., Ltd. Recent issues of this *Wiggin Nickel Alloys* have contained schematic diagrams in colour, illustrating the use of nickel alloys in sea-water evaporators, and in the "Stone-Vapor Steam Generator." There seems to have been a place for one or other of the nickel alloys in almost every mechanical, electrical and marine engineering development in 1959. A major addition in this field of knowledge was the book by W. Betteridge, *The Nimonic Alloys;* see our review in our August 21, 1959, issue.

COPPER

Facts about copper continued to be made available during 1959 by publications freely obtainable from the Copper Development Association, 55, South Audley Street, London, W.1. Twice a year it now produces a survey which covers the broad fields of copper mineral resources, production, fabrication and properties.

The breadth of the fields is indicated by the fact that the January survey contained no less than 162 bibliographical references and three pages were needed to list therein the publications of the British Standards Institution relating in varying degrees to copper and copper alloys, and to products for which they are used, which became available during the previous six months.

Upwards of fifty special publications, of potential value to students and users of copper, have by now been issued by the Copper Development Association. These cover general and historical, architectural and plumbing, agriculture and horticulture, electrical engineering and, the most numerous group, metallurgical and engineering subjects. For those who desired to be kept more closely informed of the current developments in the technology of copper, a separate monthly publication was provided, *Copper Abstracts*. There was, however, a much more easily read third publication of the Copper Development Association available and welcome to many who are engaged in engineering and technology of all kinds. This was its journal, *Copper*, a glossy quarto information magazine containing attractive and instructive coloured illustrations of present-day uses of copper and its alloys.

Copper roofing remained the choice of architects for notable buildings and, during 1959, was to be seen covering the new Planetarium in London and, on the far side of the globe, covering Australia's new Academy of Science building at Canberra.

Aluminium

The year 1959 was notable for the publicity given to the struggle for the control of Britain's oldest aluminium company. This occurred at a time when the world output of aluminium had reached a total of nearly 4,000,000 tons a year. Thus, within the lifetime of a man, aluminium has changed from being an expensive curiosity of the laboratory to a metal so important to the peoples of the world that its volume now exceeds that of all other non-ferrous metals. The U.S.A. produces over a million tons a year ; Canada, and Russia with its satellite countries, each produce about 750,000 tons of aluminium. Lacking the essential relatively cheap electricity from hydro-electric power, the output of virgin aluminium in the United Kingdom has remained at about 30,000 tons a year. But its fabrication in industry supplied ten times that weight of products of aluminium. The United Kingdom has been importing 200,000 tons a year, mainly from Canada, and recovering 100,000 tons a year from scrap.

The output of aluminium in 1959 was about twenty-five times greater than it was thirty years before, when one had thought of the metal mainly in connection with developments in aviation. The largest user of aluminium is now road transport, which takes about 20 per cent of the semi-manufactures of aluminium ; building, structural engineering and packaging are the next largest users of this metal.

In a paper on " Aluminium Technology and Railway Rolling Stock," presented to the Institution of Locomotive Engineers last October, it was stated that a complete design study is being undertaken for an aluminium main-line coach, and this is being based on the matrix force system of stress and strain analysis. In November it was reported that, of the 1000 diesel railcars produced at Derby, 414 were in aluminium alloy. By 1959 unpainted aluminium alloy coaches had also appeared as some of the electric trains of the underground railways of London. Much use was also made of aluminium alloys during 1959 in the upperworks of many ocean-going ships.

The Aluminium Development Association, 33, Grosvenor Street, London, W.1, continued to issue authoritative brochures and its quarto-sized information magazine, *The Aluminium Courier*, gives one illustrations of many of the ways in which aluminium alloys now serve.

Zinc

Of the four base metals, copper, tin, lead, and zinc, which since 1882 have been largely marketed through the famous London Metal Exchange, zinc is a relative newcomer. The statistics of the first three metals commence at the year 1801, when zinc, or spelter as it was then known, was an unimportant metal. Statistics of the annual smelter production of zinc are, however, available from 1841.

During 1959 the technical reference library of the Zinc Development Association, 34, Berkeley Square, London, W.1, continued to cover the world literature on the use of zinc and its products. The monthly booklets of Z.D.A. Abstracts reviewed this wide field. It should be noted that these zinc abstracts have recently become more truly worldwide in their coverage, for they now include references to work in U.S.S.R. and Czechoslovakia as well as Western Europe, U.S.A., and Australia. The more important items of new information are readily sought in this way, especially as the abstracts published in the previous years have been conveniently summarised in annual index booklets.

So widely is zinc now used for the protective coating of steel that reference should also be made to the Hot Dip Galvanisers Association. Many abstracts refer to developments in hot dip galvanising and other forms of zinc coating, such as sherardising, metal spraying, and zinc and cadmium plating. In the latter field one notes steady progress in the production and use of Zintec. In this electro-plating of steel strip and sheet the coatings of zinc may, if desired, be of different thicknesses on the two sides of the steel. Thus in a petrol tank, for example, the steel is provided with a thicker, more corrosion resistant coating on the side more exposed to attack by corrosion in service.

There was increased use of special alloys of zinc in the form of die castings, for details of which one should refer to the Zinc Alloy Die Casters Association. No less than nineteen technical booklets have been made available, which cover the many aspects of zinc die castings, such as their manufacture and properties, their machining, plating and durability.

Furthermore centres of technical education will be helped by a new teaching aid, provided by the Z.A.D.C.A., which now supplies, without charge, a set of five coloured wall charts, 20in by 30in, especially prepared to acquaint engineering students with the pressure die casting process.

Lead

Although the history of the usage of lead extends to remote periods of recorded time, and early lead workings have been traced throughout the Mediterranean countries, the provision of systematic technical data about this metal lagged behind some of the newer metals. It was not until 1953 that the Lead Development Association, 18, Adam Street, London, W.C.2, was formed by the principal Commonwealth producers. It now has a lead sheet and pipe section, which centralises thought on the traditional uses of lead for water pipes, church roofs, and later chemical plant and paints. More recently much lead has gone to the manufacture of electricity storage batteries and cable sheathing. Now it finds an additional outlet in atomic energy as massive biological shielding. On the other hand, minute spheres of lead to a closely controlled specification are used in the production of transistors.

During each of the last ten years the United Kingdom has used between 293,000 and 358,000 long tons of lead ; mainly for cables (100,000), sheet and pipe (70,000), and batteries (30,000). More exact figures for the consumption of lead are tabulated for the years 1949–58, under thirteen headings, in a review of the services of the L.D.A. published in May, 1959.

The More Costly Metals

Reverting to Table I, there remain the many metals sold per pound or per ounce. Space will not permit reference to each of them but the following should be noted.

Cobalt.—In 1959 we received copies of a new quarterly publication on cobalt and its uses, entitled *Cobalt*, in the form of a quarto-sized technical information magazine published by the " Centre d'Information du Cobalt," 35, rue des Colonies, Brussels, Belgium. It is published in both English and French editions. Ten years ago cobalt was in short supply and placed on the critical list. There were then only three sources of primary metal on the American continent ; in 1959 there were nine. Cobalt is no longer in danger of short supply and by late 1959 the world production capacity was estimated to reach more than 20,000 short tons. This is good news for the potential users of hard-facing cobalt-base alloys, permanent magnets, and the special cobalt containing alloys which have been used in jet engines.

Titanium.—To meet the demands for what are termed " new metals " the Metals Division of Imperial Chemical Industries, Ltd., has spent some £10,000,000 and their production of titanium, zirconium, and beryllium was described at the end of 1959 (see The Engineer, December 18, 1959, pages 819–21). Summaries of published information on titanium and its alloys are issued by I.C.I., Ltd., in bi-monthly booklet form entitled *Titanium Abstracts Bulletin*. These summaries offer a very convenient way of studying developments in the properties, working and applications of these expensive but valuable new alloys.

The Precious Metals.—Few engineers will design to use the metals listed in the third column of Table I, but several of these metals already play important roles in many scientific applications. A relatively few specialist firms make these precious metals their subjects of study. Closely connected with the South African platinum mines are Johnson Matthey and Co., Ltd., whose well-printed *Platinum Metals Review* had reached its third volume in 1959. Herein one may find a quarterly survey of research on the metals platinum, palladium, rhodium, iridium, osmium and ruthenium.

Similarly closely connected with the valuable by-products of the Canadian nickel industry, the Mond Nickel Company, Ltd., is world-famous for separating and refining all precious metals. In 1959 it described how palladium added to some established filler alloys can result in improved high temperature brazing.

A publication, *Products of the Rare Earth Group*, has just been issued by Johnson Matthey and Co., Ltd., 73–83, Hatton Garden, London, E.C.1, from whom it is available free on request by any who wish to study this potentially valuable and very topical range of materials. Elements of a sub-group of the periodic table have now emerged and become tangible because new techniques for the production of the rare earth elements in a state of high purity have been developed in the Johnson Matthey research laboratories. All of the sixteen rare earth metals have been remelted into ingots or rods. Lanthanum, cerium, neodymium, praseodymium, yttrium and gadolinium have been successfully extruded, and subsequently drawn to fine wire.

LITERATURE

Progress in Nuclear Energy: Series XI. Plasma Physics and Thermonuclear Research. Edited by C. LONGMIRE, *et al.* Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 105s.

THE papers on thermonuclear research presented to the second international conference on the peaceful uses of atomic energy, at Geneva in 1958, represent the best single body of information yet available to both the specialist and the non-specialist student of this field of work. There are to be found review articles of admirable lucidity surveying progress in various countries, articles outlining the various approaches to the problem of magnetic containment of a hot plasma, and detailed studies of particular experimental and theoretical problems. Few of the 100 or so papers presented at Geneva are yet seriously out-of-date ; many of them are still valuable mines of information.

The present book published by Pergamon Press reprints thirty-six of the Geneva papers, and one extra paper, a review of some Russian work by I. V. Kurchatov, published at about the same time. The principal national review papers (Alfvén, Teller, Artsimovitch, Biermann, Thonemann) are all there ; so are review papers covering the three principal magnetic configurations used for confining plasma (pinch, stellarator, magnetic mirror). Approximately 230 pages are devoted to the principal papers on the pinch configuration. The stellarator (forty-seven pages) and the magnetic mirror configurations (sixty-eight pages) are less fully covered. Theoretical papers dealing with hydromagnetic shock waves, run-away electrons, synchrotron radiation, the proposed Astron thermonuclear reactor, hydromagnetic stability and a number of related topics complete the volume. The selection thus serves to cover the main direction of the research reported on at Geneva.

The principal omissions are papers on energy balance problems, papers by Russian workers on the excitation of oscillations by electron beams, and papers on ion cyclotron oscillations. While some of the sixty or so omitted papers were of only ephemeral value, nevertheless such drastic selection means that the volume is of doubtful value as a reference work. The editors of this volume do not inform the readers of the principles governing their selection. Moreover, the editors have supplied neither abstracts, titles nor authors of most of the omitted papers ; indeed it is nowhere explicitly stated that the volume represents only a selection of the Geneva papers. The book is mysteriously labelled Vol. I : apparently Vol. II will be a similar selection of such papers as are presented at the next Geneva Conference, not a volume covering the present omissions.

The book is bound to invite comparison with the "authorised" version of the conference proceedings, which has now been available for some nine months, published by the United Nations. The United Nations version costs just under twice as much, contains all papers, and includes a full record of the discussions. The texts used are not in all cases identical ; and both contain misprints, often different—a useful point to be remembered by perplexed readers. While in one or two cases the Pergamon version contains material not included in the authorised version, in some cases the Pergamon editors appear to have relied on the preprints issued at the conference : the important theoretical paper of Rosenbluth on pinch stability has been printed without a glossary of symbols, and with an important diagram insufficiently labelled ; the reprint of the paper by A. C. Kolb on fast-rising mirror fields omits important material presented at the conference, the mathematics contains a large number of errors or misprints (not all of them obvious) and three of the six diagrams referred to in the text are missing.

In such circumstances, the volume under review cannot be recommended as superior to the United Nations publication in respect either of completeness or accuracy. It is, however, cheaper ; and all the papers in it are authoritative accounts covering most aspects of contemporary research into controlled thermonuclear reactions.

A Short History of Scientific Ideas to 1900. By CHARLES SINGER. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 35s.

IT is related of Louis Agassiz that he once received a request to deliver, before a working men's club, a lecture on fishes. He replied that it was a thing impossible : he would, however, be glad to offer them "a course of lectures on a fish scale." This story may be recalled by many readers of Dr. Singer's latest book : *A Short History of Scientific Ideas to* 1900 (Oxford, at the Clarendon Press), in which the author compresses into 516 well illustrated pages the ideas of some 550 philosophers, scientists and men of letters. If, as stated in the "Preface," Dr. Singer's aim has been "to give an elementary idea of how science came to occupy its distinctive position in the life of our own time" it still remains necessary to read the book with close attention and to remember, with the author, that the great aim of science "is to make the world intelligible, or at least describable." The world has certainly good reason to be indebted to those who, like Fontenelle (1657–1757), have popularised science, an activity dear also to the heart of Louis Agassiz, whose *Lectures on Comparative Embryology* (1854) are referred to by Dr. Singer and who was devoted to the need for so expounding science as to demand from the student "only a minimum of preliminary knowledge." Did he not sit, during meals, at the head of one of the tables in the combined dining and lecture room, often lecturing about a fish, the remains of which lay upon the plates ?

To us no part of Dr. Singer's book proved more refreshing than section (VII) entitled "The Insurgent Century (1600–1700)." While the century in question witnessed a momentous exposure of errors in the mechanical doctrines of Aristotle, it will be remembered that the Stagirite remains an unsurpassed promoter of learning. Did not Dr. Johnson quote, with great warmth, a saying of Aristotle to the effect that there was the same difference between one learned and one unlearned as between the living and the dead ? It is the exposition given in regard to what is called the "downfall" of Aristotle that renders Section VII of Dr. Singer's book so well worth reading and meditating; indeed, were Aristotle himself to see this book he would, we imagine, be quick to commend the author.

Among other movements which illumined the "Insurgent" century were (1) the impetus given, particularly by Fontenelle, to the encyclopædic treatment of science, and (2) the introduction of the skilled mechanic into the service of science, a movement which Dr. Singer regards as having received important encouragement from Galileo. It was a celebrated economist who maintained that "All good things which exist are the fruits of originality" and while to the engineer this expression becomes more satisfactory when the quality of originality is associated with that of effort, great stimulation is to be found in a chronological symposium of scientific ideas such as that compiled by Dr. Singer. Impressive indeed is the underlying recognition of the truth proclaimed by the poet Cowper in the well-known lines wherein he declares how :

> "Knowledge dwells
> In heads replete with thoughts of other men ;
> Wisdom in minds attentive to their own."

It is to wisdom that we may best look for the technology which has been described as "science applied to the business of life" and here we are well advised to recall some words uttered during 1886 by Henry Robinson Towne who, in a paper entitled "The Engineer as an Economist," remarked that "The true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically." Since Towne delivered his paper the deepening of technological complexity has added greatly to the problems of the engineer, but so long as the qualities of imagination and diligence persist among entrants to all departments of engineering activity we may cherish good hopes for the future. Let us not forget the paragraph in his *Essay Concerning Human Understanding* (1690) wherein John Locke points out that "everyone must not hope to be a Boyle or a Sydenham ; and in an age that produces such masters as the great Huygenius and the incomparable Mr. Newton, with some other of that strain, it is ambition enough to be employed as an under-laborer in clearing the ground a little and removing some of the rubbish that lies in the way to knowledge." Not seldom the work of the "under-laborer" proves momentous, as in the case of Thomas Newcomen the iron-monger ; Richard Arkwright the barber and peruke-maker ; Michael Faraday the book-binder's apprentice, and Sydney Gilchrist Thomas, the police-court clerk. The educational backgrounds and material resources of these men were slender indeed, but they possessed the rare capacity which Shakespeare had in mind when proclaiming that :

> "As imagination bodies forth
> The forms of things unknown, the poet's pen
> Turns them to shapes."

We would like to suggest that a name of singular interest in the history of scientific ideas is that of Denis Papin, whose activities as mathematician and inventor have not always received the applause they merit,

notably in respect of his collaboration with Boyle and Hooke.

He deserves mention, moreover, in respect of the contents of his *Acta Eruditorom Lipsiae* (1690), describing for the first time apparatus for the production of a vacuum by the condensation of steam under a piston. The same publication describes a device which appears to embody the essential characteristics of the modern centrifugal pump. The omission of Papin's name is not cited in criticism of a book which deals with the history of scientific ideas rather than of mechanical engineering. There is, however, a region between the two subjects which may be regarded as common ground, ground from which has sprung much of the essential apparatus of our civilisation. It is to the workers and potential workers in this common ground that Dr. Singer's admirable book is primarily addressed, and we can think of no compilation more likely to stimulate their intellectual activity so long as they follow, when studying it, the plan laid down by the author.

Uber Herde Elastischer Wellen in Isotropen, Homogenen Medien. By F. GASSMANN. **Die Interpretation von Seismischen Reflexionsmessungen mit Abgebrochenen Potenzreihen.** By MAX WEBER. Mitteilungen aus dem Institut für Geophysik, No. 34. Eidgenössische Technische Hochschule, Leonhardstrasse 33, Zürich, 6. Free to scientific institutions on application.

IN this publication are collected two papers which had previously appeared in *Geofisica Pura E Applicata*, Volume 40, 1958, page 55 and page 19. In "Sources of elastic waves in isotropic, homogeneous media," Professor Gassmann considers the solutions of the scalar wave equation, and gives an expression in spherical co-ordinates of the density and flow of energy in the case of small displacements, and also deals with general multiplets satisfying the equation of motion. As special cases, multiplets with excitation of finite length and multiplets with periodic excitation are considered, and solutions of the equation of motion and of curl $s=0$ and div $s=0$ are given. It is also shown how elastic waves whose origin is a region of finite extent in the sense given by Stokes can be approximated by elastic multiplets. Some indications are given of how to find the functions of excitations and the energy of an elastic multiplet by measuring in the interior of the medium components of s or $\dot{s}$, &c. The same problem is considered in the case of a single elastic pole if the measurements are made at the surface of an elastic half space.

Dr. Weber, in "Interpretation of seismic reflection measurements with broken-off power series," treats in a general and exact manner the problem of seismic reflection in a uniaxial, inhomogeneous medium, the assumption being that the travel time function can be represented by a broken-off power series. In addition, an approximate solution for inclined surfaces of discontinuity and an example are given.

The World's Lighthouses Before 1820. By D. ALAN STEVENSON. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 63s.

MANY of the world's lighthouses, lightships and other aids to navigation have a fascinating history both in respect of their establishment and their equipment. Hearsay is also quoted as true history in many instances. Some of these interesting details can be gleaned from books and papers not readily accessible to lighthouse engineers and administration authorities which are naturally spread all over the world. In *The World's Lighthouses Before* 1820 Mr. Stevenson has not only collected the details into one book but has also given sound reasons for dismissing much of the hearsay referred to above, so that the true history of these aids to navigation has been revealed. Similarly, the development of illuminating apparatus and fog signals over this period has been treated logically and fully. This is a veritable catalogue on lighthouse development and as such is a notable addition to the library, not only of those connected with the requirements of lighthouses but also surely of the historian. It is most fitting that this work should have been written by a member of one of the most illustrious families connected with lighthouse building.

There is to be a second volume on lighthouses, 1820–1960, by the same author which should also be of great value if prepared with the immense care and detail with which Mr. Stevenson has prepared the book under review.

Worked Examples in Applied Mechanics. By W. C. DURNEY. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, London, W.C.2. Price 12s. 6d.

THIS book is a collection of questions from examination papers in the subject of Applied Mechanics. A number of these questions are presented as exercises for the reader, but to most of them detailed solutions have been added. The standard is that of the Ordinary National Certificate and the questions are representative of mechanical engineering practice. This is not a text book, but here and there are notes about the basic principles upon which groups of solutions depend. The declared aim of the book is achieved and it will greatly aid those who seek opportunities to gain practice in solving problems typical of mechanical engineering. This is the most reliable way of becoming conversant with the arithmetic of applied mechanics in industry.

In any technology, accuracy of terminology is specially important to the student even though it may not be essential to anyone else. It is consequently unfortunate that in this book "second moment of area" is rendered as "moment of inertia" in accordance with an undesirable custom that probably originated in the common use of the symbol I to represent this quantity. It is particularly regrettable that in at least one solution (page 71) true moments of inertia might properly be considered while the name itself is actually applied to "second moment of area." Although few inveterate users of any term will abandon it, no matter how badly newcomers may be confused by it, there is a case for introducing substitutes for unsatisfactory names in a book of this kind, or at least for explaining why the conventional terms were better abandoned.

The subjects considered are "Strength of Materials," "Forces in Frame Structures," "Dynamics and Hydraulics." Any student who has successfully worked through all the problems in this book has well consolidated his understanding of elementary mechanics applied to engineering.

Books Received

Bibliography on the Continuous Casting of Steel, 1956-1959. (Bibliographical Series No. 21a.) Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Price (non-members) 25s.; members 15s.

The Electro-Hydraulic Analogy of Switching Circuits. By Joseph M. Case and Ernest C. Fitch, Jr. Engineering Experiment Station, Oklahoma State University, Stillwater, Oklahoma, U.S.A. Price 1 dollar.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

FLAT BOTTOM RAILWAY RAILS: STEEL FISHPLATES FOR RAILWAY RAILS

No. 11 : 1959. Price 17s. 6d. A completely new series of railway rails comes into being with the issue of these revised editions of these specifications. The new rails are those in the weight range of 65 lb per yard up to and including 110 lb per yard, and will be referred to as the "A" series. The standard no longer specifies sections for rails in the 115 lb–120 lb per yard range, and sections remain unaltered for rails in the 25 lb–55 lb per yard range, as they do for the 60 lb per yard rail.

Since the existing series of flat bottom rail sections was introduced over thirty years ago, practices regarding the mounting of rails on sleepers have changed and considerable knowledge has been acquired regarding the distribution of stresses within the rail. In considering a revision of the sections, the British Standards Institution called on the practical experience of railways using the old sections and their researches into way in which these might be improved. This experience led to the following conclusions :

(1) Very high stresses can arise in the fillets joining the web to the head and foot of the rail.

(2) High stresses can be induced in the vicinity of bolt holes under the wedging action of flat fishing angles.

(3) Unequal top and bottom fishing angles lead to differential wear, resulting in tilting of the fishplates and deterioration of the joint.

(4) A better disposition of available metal can be obtained by reducing the foot width, without affecting stability or giving an inadequate bearing area.

The British Railways 109 lb per yard rail was designed as a result of similar studies, and in view of its satisfactory performance in 7000 miles of intensively loaded track, B.S.I. adopted it as the basis of design for B.S. 110A, and for the whole of the "A" series. That this design is well proportioned is borne out by the fact that the International Union of Railways selected it, and with very minor adjustments to meet certain continental requirements, it was adopted as the U.I.C. 54 kg per metre rail.

Compared with the old section the "A" rail series has larger fillet radii—that joining web to head being a compound radius. The use of equal top and bottom fishing angles has resulted in the reversion to the double angle foot, in order to obviate an unbalanced section with excess metal in the foot. Foot widths have also been reduced, again allowing a better disposition of metal within the section. The sides of the head have been tapered at 1 in 20, which not only gives additional metal to resist side wear but also increases the width of the top fishing table.

The old rail series had a head radius of 9in, which corresponds to the radius to which rails normally wear in service. The increasing trend towards heavily loaded wheels of small diameter does, however, induce high stresses when tyres are new and makes a larger radius desirable at the point of contact. These two conflicting requirements have been met by the introduction of a compound radius in the larger sections, 12in over the central portion of the head, followed by a sharper radius to give an overall average approximating to 9in. This offers the added advantage of reducing the tendency towards "corner shelling." For sections below category 95A, this compound radius is of less practical significance and a simple 12in radius is employed.

No. 47 : 1959. Price 20s. With the re-design of the heavier rail sections, opportunity has been taken to incorporate in a revised standard for their fishplates the experience gained since the previous series was devised. Since fractures in fishplates frequently originate at the very top, the new fishplates have been designed to minimise the stresses at this point by using the largest practicable radius and raising the neutral axis. In order to achieve this, the bolt holes are located slightly below the neutral axis. The contour of the top of the fishplate is such that contact between it and the flange of a fully worn tyre could only occur under the abnormal combination of maximum rail headwear and sidecutting.

SPRING CALIPERS AND SPRING DIVIDERS

No. 3123 : 1959. Price 4s. This publication specifies requirements for spring calipers and spring dividers with rectangular section, squared section, and covered section legs.

Components of spring calipers and dividers are rarely supplied as spares, and detailed consideration has only been given to those parts which directly affect the quality, functioning and life of the complete instrument. To this end, the material, heat-treatment, manufacturing and testing clauses are designed to ensure that the instruments are satisfactory.

I.C.E. "General Conditions of Contract"

THE ENGINEER AS ADJUDICATOR AND ARBITRATOR

By F. NEWHOUSE, F.C.G.I., B.Sc., M.I.C.E., M.Cons.E., M.I.W.E.

The Consulting Civil Engineer's duties can be roughly divided into two parts : first, survey, design, drawing-up specifications and bills of quantities, drafting the contract and advising the client on choice of contractor ; secondly, supervising the construction of the works, including modifications of design, measuring works and preparing certificates for payment and dealing with contractors' claims. Every civil engineering contract of any importance starts with the sixty-eight clauses of the "General Conditions of Contract" (revised January, 1955), which are recommended for use by the Institution of Civil Engineers, jointly with the Association of Consulting Engineers and the Federation of Civil Engineering Contractors. The following article analyses the ambiguities and contradictions in some of the clauses, whose combined effect is to leave the employer, the contractor and the engineer in a state of uncertainty as to the equity of a contractor's claims, a contractor's rights, the employer's rights and the engineer's duty. Certain clauses, principally clauses 6, 17 and 20(2), help the contractor, while nearly all the remainder help the employer, especially clauses 8, 11, 12 and 52. Clause 11 is picked out as being the one most in need of redrafting, while clause 52 can be used to hamstring the engineer, and consequently the employer (the consulting engineer's client). The engineer is hampered in adjudicating on a claim by the fact that his decision is not final. It can be rejected by either the contractor or the employer, and arbitration can be demanded before an independent engineer, acting with the powers allotted to him by the Arbitration Act of 1950. An engineer can, of course, not become the arbitrator of the 1950 Act on any works of which he has been "the Engineer" of the Institution of Civil Engineers' Conditions. A brief description is given of the powers of an engineer as arbitrator, showing how much easier his problems are than in the cases where he has merely been "the Engineer" of the I.C.E. Conditions, despite the fact that there are more than twenty ways in which an arbitrator can be guilty of misconduct, justifying an appeal to the High Court by either of the parties to a dispute. The article concludes by pointing out that while the I.C.E. Conditions are indispensable in administering a contract, they could be made more valuable by redrafting a few clauses to eliminate ambiguities and inconsistencies.

EVERY civil engineer who is qualified by education and experience for the post of resident engineer on important works will be acquainted with the Institution of Civil Engineers' "Conditions of Contract," in which the duties of "the Engineer" and "Engineer's representative" are specified. He will also have pondered on Clause 66 of these conditions, which lays down the routine for dealing with claims in which the Engineer has to adjudicate, and later in the same clause the routine for claims in which an Arbitrator is appointed by the President of the Institution of Civil Engineers.

Differences between employer and contractor occur constantly on works, but are mostly of a nature that can, and should, be settled by the Engineer's representative (the resident engineer) within the limits of his delegated powers. When major disputes occur, the Engineer himself must act. The important thing here is that the Engineer, when exercising his functions as laid down in Clause 66, is not an Arbitrator. Halsbury's *Laws of England* (third edition) state quite clearly, in paragraph 8 of the "Comments on the Arbitration Act, 1950," that "An engineer is not an arbitrator where a contract simply provides that on certain matters his certificate is conclusive." "Simply" in this quotation sounds like sarcasm.

The Engineer will have entered into an agreement with his client, which should be as close as possible to the type agreement of the Association of Consulting Engineers. Clause 11 of the latter's standard form of Agreement for Consulting Engineers is entitled "Care and Diligence" ; it provides that "in so far as any of their (the engineers') duties are discretionary (they) shall act fairly as between the client and the contractor or contractors." The "client" in this document is the same as the "employer" in the Institution of Civil Engineers' Conditions. The Association of Civil Engineers thus prescribes a moral attitude for the engineer, but offers no code of practice, which, therefore, the engineer has to evolve from his own experience.

A claim, in the language of contracts, is a demand by the contractor for payment additional to the amounts shown in the bills of quantities. The grounds on which a contractor seeks to justify his claims fall into four main categories. First : changes in the design or scope of the works ; secondly, the occurrence of earth or rock different from the descriptions in the specification and bills of quantities ; thirdly, ambiguities, mistakes and omissions in the contract documents, and, fourthly, natural and social causes such as storms and earthquakes, fires, strikes, bankruptcy, war, &c.

Clauses 63 to 65A of the "Conditions" deal with the fourth category of claims, which generally have to be handled by solicitors, who would require the Engineer as technical assessor only. In most contracts in normal times claims in this category seldom arise, while in any case they cannot be considered within the limits of this article.

Practically every claim in the first three categories includes compensation for delays that are alleged to cause interference and disturbance of organisation and thus extra costs, because plant stands idle and has to be moved while labour is not fully employed and "overheads" (the stand-by of the contractor in any claim) mount and mount. All this, of course, in addition to agreeing new rates, based on actual contract rates, for any operation that is not coverable by any bill item.

There is a number of clauses in the conditions which give shelter either to the employer or the contractor. They are subject to abuse by either side, owing to lack of clarity. Those that help the contractor are Clauses 6, 17 and 20(2), while the ones that help the employer form practically all the rest of the conditions, the more important being Clauses 8, 11 and 12, of which Clause 11 is the most vicious from the contractors' point of view, and the most difficult to interpret "fairly" for the Engineer. Clause 52, Sub-Clause 4, seems to give the Contractor a wide opportunity to evade his responsibilities, and puts the Engineer in the position of having to accept any statement the Contractor cares to make, as will be shown later.

Permission has kindly been given by the Institution of Civil Engineers to quote the "Conditions" for the purposes of this article. Their complete title is "General Conditions of Contract and Forms of Tender, Agreement and Bond for Use in Connection with Works of Civil Engineering Construction." The latest edition is the fourth, dated January, 1955.

Clause 11 reads as follows :

"The contractor shall inspect and examine the site and its surroundings and shall satisfy himself before submitting his tender as to the nature of the ground and sub-soil (so far as is practicable) the form and nature of the site, the quantities and nature of the work and materials necessary for the completion of the works and the means of access to the site, the accommodation he may require and, in general, shall himself obtain all necessary information (subject as above mentioned) as to risks, contingencies and other circumstances which may influence or affect his tender."

The snags for the contractor are in the last three lines, but the words in the two parentheses help him. It is not practical to say the contractor is to satisfy himself as to "the nature of the ground and sub-soil" ; he can do little but study the information given in the contract documents in the form of verbal descriptions and, chiefly, vertical sections of borings. A contractor, by making a few additional borings in the time at his disposal, between the call for tenders and date for receipt of tenders, could not obtain information that had eluded the employer and his engineer. The clause appears to have been drafted to protect the employer, when he has been unable to allow his engineer sufficient time and funds for the investigation that a big civil engineering project requires before plans are made. In fact, it is seldom possible to be sure beforehand about the foundations of large buildings or the nature of all the "sub-soil" that may be met in long channels, banks or tunnels, for the reasons given in the preface to that authoritative work, *Soil Mechanics and Practice*, by Terzaghi and Peck (1948). If quantities and descriptions of the possible variations were inserted in the bills of quantities as "provisional" items they would be as unrealistic as the rates that would have to be quoted for them by tenderers. Though it is not possible, on technical grounds, for the engineer or the contractor "to satisfy himself as to the nature of the ground and sub-soil," it should not be beyond the wit of the professional bodies concerned to draft a clause that allows for the probability that there may be significant departures of unknown magnitude from the descriptions of these items in specifications. The new clause should formulate rules to be followed when the inevitable occurs (perhaps as a sub-clause of Clause 11), while at the same time Clause 11 should be amended by leaving out at least the unacceptable words "satisfy himself . . . as to the

nature of the ground and sub-soil (so far as is practicable)."

The question being dealt with in this article is the position of the Engineer when such claims occur under the present "Conditions." The Engineer, having made the contract documents which the Employer has accepted, has now to defend the Employer's interests, and, at the same time, be fair to the Contractor who has tendered on the basis of his (the Engineer's) documents and plans. Attention is now drawn to a proviso in the first few lines of Clause 66 of the "Conditions" as shown in the following abstract :

Abstract of Clause 66.—"If any dispute or difference of any kind whatsoever shall arise between the Employer or the Engineer and the Contractor . . . it shall be referred to and settled by the Engineer who shall state his decision in writing . . . to the Employer and the Contractor. Such decision . . . shall be final and binding upon the Employer and the Contractor until the completion of the work and shall forthwith be given effect to by the Contractor . . . whether notice of dissatisfaction is given by him or by the Employer as hereinafter provided or not."

The words to be noted are : "If any dispute or difference of any kind whatsoever shall arise between the Employer or the Engineer and the Contractor." Ordinarily, a dispute or difference could arise only between the Engineer and the Contractor, for the Employer would not let the Contractor go to him over the Engineer's head. If then the prescribed course is followed in which the Contractor submits any claim direct to the Engineer, it would appear to be the latter's duty at this stage, only to inform the Employer of the nature and amount of the claim. He should not discuss the matter with the Employer, or receive instructions from him, for, as soon as a claim is made, the Engineer is in the position of having to act "fairly" in the manner of adjudication of the dispute. He is not, however, an arbitrator, for either party to the discussion may reject the Engineer's decision and go to arbitration under the Arbitration Act, 1950. That is the great difference between the Engineer and the Arbitrator, for the latter's award in any dispute is declared in the above Act to be final and binding. There is, of course, the right of appeal to the High Court, though the power to revoke the decision of an arbitrator is only exercised in a most cautious manner (Halsbury, paragraph 41). If the Engineer had discussed a contractor's claim with the Employer, it would be difficult for him to maintain that he had held an unprejudiced attitude to the claim. What is it that could be discussed between the Employer and the Engineer at this stage, as the Engineer should know more about the progress of the works and the difficulties encountered by the Contractor than the Employer can know ? The only purpose and subject of discussion would be a recital of the financial and administrative difficulties that would arise if the Engineer's decision were in favour of the Contractor or exceeded some stated amount. If, thereafter, the Contractor were so dissatisfied with the Engineer's ruling that he decided to go to arbitration, the Employer would be at a disadvantage, for the Contractor could declare that the Engineer's decision had been influenced by the Employer, a statement it would be difficult to refute. In such circumstances any evidence the Engineer might give in favour of the Employer, could easily be discredited under hostile cross-examination by counsel.

Counsel could refer to the Employer's relation to the Engineer, which is equivocal, for by Clause 1, Sub-Clause (*c*), of the "Conditions," the Engineer is only appointed "from time to time" by the Employer, or, to put it brutally, he can be sacked at any time. The sub-clause reads as follows :

Clause 1, *Sub-Clause* (*c*).—"'Engineer' means . . . or other the Engineer appointed from time to time by the Employer and notified in writing to the Contractor to act as Engineer for the purposes of the Contract in place of the said . . ."

Such action as sacking has probably never been taken, but the mere possibility should not be present in respect of a post whose occupant has such duties thrust upon him as are included in the "Conditions," especially in Clause 66. There is little doubt that counsel could make most harmful suggestions about the effect of Clause 1 (*c*) on any decision by the Engineer.

If the Employer had engaged some other engineer to advise him in an arbitration, because he did not agree with his own Engineer's opinion, it would be open to Contractor's counsel to call on the original Engineer to give evidence, a most undesirable event from the Employer's point of view. It would seem that Clause 66, as it now stands, makes it imperative for the Engineer not to consult the Employer before deciding his own judgment on a claim, and, secondly, for the Employer to accept the Engineer's explanations, unless he can find omissions or faults therein which cause the Engineer to amend his own previous judgment. Clause 66, in its present form, gives the Engineer's opinion a status, which the Arbitrator would find difficult to upset even if he wanted to. To maintain this status, Clause 66 should be redrafted in such a manner as not to to put employer, engineer and arbitrator in the invidious positions that could arise under the present wording. Further, the Association of Consulting Engineers might care to consider whether Clause 1 (*c*), as now worded tends to put the Engineer under duress to decide disputes in the Employer's favour, contrary to the provisions (quoted previously) of the Association's standard form of Agreement for Consulting Engineers to act "fairly."

Clause 12 of the "Conditions" has seven sub-clauses. Sub-Clause (1) tries to make it impossible for the Contractor to make a claim. Sub-Clauses (2) and (3), however, foresee the possibility that he might "reasonably" have a claim in certain circumstances, and then give instructions about the long and complicated series of actions he must take in such a case. Sub-Clause (4) defines the Engineer's duties and powers. He can accept the Contractor's claim, but may, if he likes, do so in such a way that the Employer does not have to accept it. (Does Clause 66 cancel this, or not ?) Sub-Clause (5) deals with procedure, while Sub-Clause (6) refers the whole matter to an arbitrator to be appointed as provided in Clause 66. Sub-Clause (7) says the Contractor can make further claims, if he wants to.

The outstanding feature in this collection of sub-clauses is No. (6), which gives detailed instructions to the future arbitrator on how he is to think, what facts he is to consider and what his award is to be. It is suggested with respect, as the saying is, that the "Conditions" could include instructions to the Contractor and the Employer about the references in the above arbitration, but should not include any suggestion of giving orders limiting the authority of the future arbitrator, as set forth in the Arbitration Act.

Clause 8 gives the Engineer powers to issue "further" drawings and instructions, that is, presumably, "further" to the contract documents. It seems that any errors or omissions in such further drawings cannot be defended behind the entrenchments of Clauses 11 and 12, as the Contractor has not been required to study and agree the "further drawings" before they are enforced.

We come now to Clause 17, which is necessary for successful control of the works by the Engineer, though a little puzzling when taken in conjunction with other clauses. The puzzling words are : "if any error shall . . . arise . . . the Contractor . . . shall at his own expense rectify such error . . . unless the error is based on incorrect data supplied by the Engineer . . . in which case the expense . . . shall be borne by the Employer." Errors and ambiguities do, unhappily, arise in contract documents, but it is not uncommon for the Engineer, in such cases, to rely on Clauses 11 and 12, previously discussed. These two clauses provide that the Contractor, having studied all the contract documents, visited the site of works, &c., has quoted rates in his tender sufficient to cover all mistakes, omissions and other faults in the contract documents, as well as the vagaries of tide and tempest. An effort could, perhaps, be made to clarify the relation of Clauses 11 and 12 to Clauses 8 and 17. At present these four clauses, taken together, form a lawyer's paradise.

While Clause 8 mentions only documents issued by the Engineer Clause 17 refers to incorrect instructions issued by the Engineer or Engineer's representative. The latter's powers seem somewhat elusive, for Clause 2 both permits the Engineer to override his representative's given approval and permits the Contractor to refer any decision of the representative to the Engineer. Clearly the powers and rights of the Engineer, his representative and the contractor should be clarified in some straightforward clause, eschewing the use of such words as "rea onably" (not susceptible to precise engineering definition), but leaving the R.E. in no doubt as to the limits of his authority.

The main ways of harrying a contractor with the help of the "Conditions" have now been discussed, far from fully, but sufficiently for the present. Now comes the study of those clauses which give the Contractor an "out." They are three, namely, Clause 6, Clause 20(2), and Clause 52(4). Of these, Clause 6 is the strangest, especially when read in conjunction with Clauses 11 and 12, which come after it. Paraphrased, its effect is to admit that there might, after all, be ambiguities and discrepancies in the contract documents, which the Engineer can be asked to clarify. The Engineer is then to decide whether his clarification involves the Contractor in extra cost, because the Contractor had "no reason to anticipate the aforesaid ambiguity or discrepancy," whereupon the Engineer "shall clarify and the Employer shall pay" the extra cost. No question of arbitration here ! Though this must all be happening after the contract is signed and the work begun, Clause 6 admits the possibility of ambiguities, &c., and says the Employer must foot the bill. How is this to be reconciled with Clauses 11 and 12, which premise that the Contractor has allowed for such faults in his tender ? Clauses 6 and 17 seem to be in accord with a well-known principle of English jurisprudence, to the effect that any ambiguity in a document is to be construed strictly against the party that drew up the document, while Clauses 11 and 12 seem to infringe this principle or deny the possibility of ambiguity or error. However, the authors of the "Conditions" have retired further from these impregnable

clauses, by introducing Clause 20, which ought to gladden the heart of every contractor's agent. The first sub-clause of Clause 20 makes the Contractor responsible for everything all the time, but introduces the phrase "excepted risk." The point of this is that the Contractor has to be paid for expenses incurred owing to such risks, which, according to Sub-Clause 2, include "a cause solely due to the Engineer's design of the Works."

The Engineer, exercising his duty to judge a claim as provided in Clause 66, and acting fairly as between the Contractor and the Employer (his client) as provided by the code of the Association of Consulting Engineers, deprived by Clauses 6 and 20 and the laws of England of the right to make the Contractor responsible for not having spotted all the errors and ambiguities in his documents (if any), is driven to consider the Contractor's claim from the Contractor's angle, notwithstanding Clauses 11 and 12, to say nothing of 1 (*c*). By exercising his knowledge of the works, by the use of his resident engineer's works' diary, by scrutinising the Contractor's break-down of his rates, he may hope to reduce the original claim substantially. He can no longer rely on Clause 11 to justify a refusal to give it consideration.

Clause 52, in Sub-Clauses (1), (2) and (3) lays down the procedure—or ritual—to be followed by the contractor who proposes to claim for "extra or additional" work. The first four lines of Sub-Clause (4) say no claim shall be admitted if the ritual is not performed exactly, but the last three lines in the same sub-clause give the Contractor an opening to skip all the ritual if he has notified the Engineer at the "earliest practicable opportunity" that he is going to make a claim. Now, the O.E.D. says "practicable" means "feasible" and that "feasible" means "practicable" and also "serviceable" and "plausible." The Conditions appear to say that if a contractor can make a plausible excuse for not having claimed at once he can claim any time he likes. Surely, the engineer is entitled to ask the authorities who have produced "the Conditions" to say what they mean in clear English. How are the words "earliest" and "practicable" to be interpreted in the context of the Conditions? What does the Association of Consulting Engineers mean by "fairly"?

If the Engineer advises his client, the Employer, to reject a claim, or alternatively the Employer refuses to accept the Engineer's opinion that a claim should be paid, then the Employer and Contractor can negotiate direct. Such bargaining often brings agreement, because both sides wish to avoid the delay, expense and risks of an arbitration; otherwise, an arbitrator is appointed by the President of the Institution of Civil Engineers at the request of both parties.

The arbitrator will be someone quite unconnected with the contract under reference, or either of the parties to the dispute, and therefore cannot be the same person that has been the "Engineer" of one of the parties, the Employer. He will usually be an engineer of experience in the kind of contract and works that are the subjects of dispute, and, will therefore be well acquainted with the Institution of Civil Engineers' Conditions, and will have acted as the "Engineer" in many claims made by contractors. Even if he has not previously been arbitrator, it will not take him long to grasp the spirit of the Arbitration Act of 1950, together with the authority and limitations imposed on him thereby.

The Act is short and easy to understand, while the Institute of Arbitrators could provide reference to modern commentaries when asked. There is always, of course, Halsbury's "Laws of England" (Vol. III) as a guide to previous applications of the Act, in a section not too long, nor too difficult for the non-legal mind to follow.

An engineer should realise that as Arbitrator, he will be in a very different position from that of "the Engineer" to an employer. In the latter position he is a negotiator; he can try and convince both parties separately that his decision is fair to both. As Arbitrator he has to face the fact that there are over twenty ways of "misconducting" himself during the arbitration proceedings, ranging from taking bribes to asking one of the parties a question of which the other is not informed. He does not have to convince either party of the justness of his awards, but has to get enough evidence to convince himself. He cannot be called on to give reasons for his awards, but must be as aloof from all connected with the disputes as a judge. He will study the contract, of course, but is not bound by the instructions it contains as to his procedure, though he should be prepared to justify to the High Court any action he has taken, in case either party appeals. Compared with the difficulties facing "the Engineer," the work of the Arbitrator is straightforward.

It is hoped that the necessity for a revision of the Institution of Civil Engineers' "Conditions" has been demonstrated sufficiently. They give essential help to every engineer while drawing up contract documents and controlling works, but bear the marks of having been compiled by divergent minds that have been forced to accept compromises to meet the views of employer, engineer and contractor. Compromise has produced a document that is sometimes inconsistent, and therefore causes sloppiness, both in drafting a specification and in the resulting tenders. All engineers are grateful for the "Conditions," but would be even more grateful if they were made clearer by re-drafting the clauses discussed in this article. Any new edition should also include a Code of Practice embracing the duties of all concerned in settling the final account of a contract.

Electronic Boiler Control at Little Barford "B" Power Station

The first electronic system of automatic boiler control in a C.E.G.B. power station is in operation at Little Barford "B" power station, near St. Neots. The generating plant consists of two Foster-Wheeler 550,000 lb per hour (c.m.r. rating) p.f. fired, outdoor boilers supplying steam at 900 lb per square inch and 900 deg. Fah. to two 60MW Parsons turbo-alternators. Each boiler/turbo-alternator set operates as a unit with a cooling tower. Boiler combustion conditions are controlled automatically to match steam demand by the Evershed and Vignoles electronic system based on the use of transmitters, simple analogue computers and three-term controllers operating valve and damper positioners, as described here.

LITTLE Barford "B" power station on the Great Ouse river, about 1½ miles south of St. Neots, has two 60MW generating units and is the first C.E.G.B. station to make use of electronic control for the remote operation of each boiler unit from a central plant operating room. This system of control detects load changes in terms of the boiler outlet steam conditions, determines the appropriate changes in combustion conditions to suit the new load and makes the necessary adjustments.

With the commissioning of the new station the site capacity has now been developed to 240MW, as was envisaged when the first station was being planned in the early part of the last war. Little Barford "A" power station, which was completed in 1942, has four 30MW generating sets. The intention then was to install two 60MW sets in a new station, Little Barford "B," but the scheme was deferred until after the war. Indeed site work did not begin until 1956 and the schedule provided for the first set to be commissioned in the second quarter of 1958 and the second set a year later. However, further delay was caused by the restrictions imposed on capital expenditure and the first set was eventually commissioned in March, 1959, and the second in October, 1959.

The "B" station is built to the south-east of the "A" station and is separated from it by the common administrative offices. Further to the south-east, and beyond the road between St. Neots and Little Barford, is the coal store for both stations. The cooling towers are south-west of the main buildings.

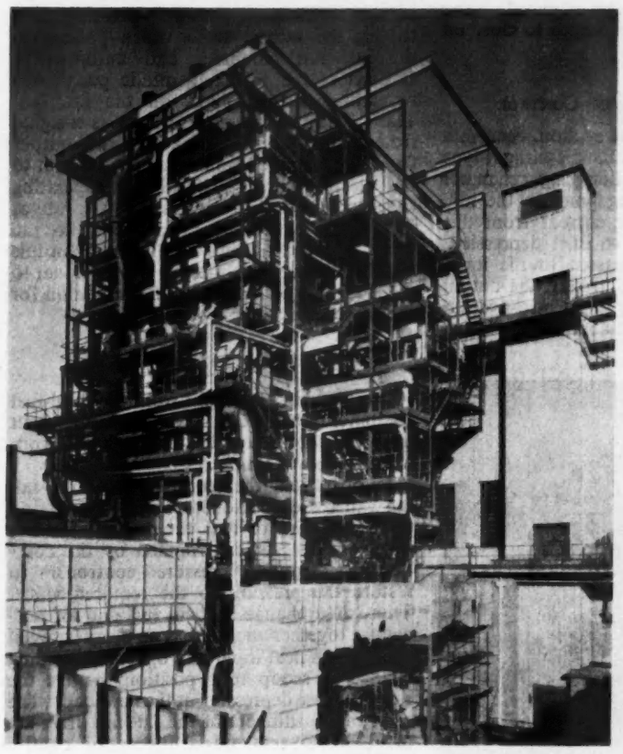
Although the general layout of the new station is conventional there are a number of departures from common practice. As already mentioned, the instrumentation and automatic control of the two boilers is carried out by an electrical system developed by Evershed and Vignoles, Ltd., and complete operation of the two units is effected from a separate plant operating room in the main building.

Each turbo-alternator operates as a self-contained unit with its own cooling tower in a closed circuit system for the circulating water. This arrangement has made it possible to omit valves in the main circulating water lines. The water end of each condenser is divided into two sections, each section being fed by a variable-pitch propeller pump. Although the suction pit is common to both pumps the discharges remain separate up to the irrigation level in the individual cooling towers. One of the functions of the Evershed control system is to maintain optimum efficiency by matching the pump output to the value of the condenser vacuum.

Coal is brought by rail to the station sidings and is handled by wagon tippler with a gravity bucket and conveyor system. Motor scrapers are used for stocking out and for reclaiming coal from the store. Air suction is used, instead of water sluicing, to extract ash and dust from the boiler ash hoppers, air heaters and precipitators. Each boiler has its own ash and dust system working from common exhausters which pump the dry dust to bunkers. Thence the dust is transferred by mixed conveyors to road lorries and is tipped into a nearby pit.

As illustrated overleaf, the boilers are of outdoor construction. The only part of the boiler proper that is enclosed is the burner face and the mills and ash-handling equip-

ment are housed in a basement. A bitumastic waterproof coating protects all lagging and ductwork exposed to the atmosphere. Most of the drum area is covered by similar waterproof materials but the drum ends and the equipment for water level detection are enclosed in local penthouses.



Outdoor boiler, c.m.r. 550,000 lb per hour, at Little Barford "B" power station

The boilers are Foster-Wheeler single-drum units with eight p.f. burners in the front walls. They are designed for a continuous maximum rating of 550,000 lb per hour at 950 lb per square inch and 910 deg. Fah. at the superheater outlet.

Control of the steam temperature over a load range from 80 to 100 per cent of continuous maximum rating is by the use of a hollow tube surface condenser to alter the wetness fraction of the saturated steam entering the primary superheater. The air heaters are tubular. Control of the i.d. fan is exercised by a hydraulic coupling but that of the f.d. fan is by movable vanes in the fan itself.

The turbo-alternators are Parsons 60MW two-cylinder impulse reaction machines, with condenser conditions of 1·3in Hg. abs., as cooling towers are used exclusively. Feed water is heated to 385 deg. Fah. by five-stage steam extraction. The alternators are cooled by hydrogen at 15 lb per square inch and the generated voltage, 11·8kV, is stepped up to 132kV by generator transformers.

Water for boiler make-up is obtained, without the use of evaporators, by a demineralisation plant fed with a piped water supply from Tempsford, about 3 miles away.

Boiler Control Scheme

The Evershed scheme described here is designed for the independent automatic control of the two boilers, each of which is equipped with two horizontal double-ended mills, two induced-draught fans and two forced-draught fans, the steam temperature being controlled by regulating the water flow to a Foster-Wheeler attemperator.

In describing the control system it is convenient to consider the scheme as being subdivided into the following functional groups:

1. Master control of rate of fuel input.
2. Mill inlet suction control.
3. Mill outlet mixture temperature control.
4. Combustion chamber pressure control.
5. Air/steam flow ratio control.
6. Steam temperature control.

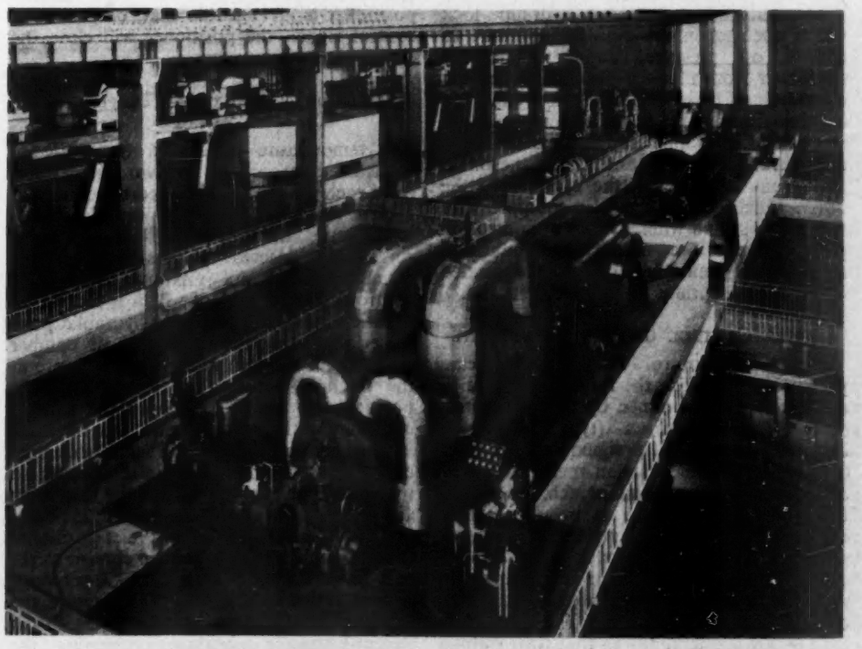
The main equipments used in the control system are transmitters, three-term process controllers, elementary analogue computers and positioners.

Transmitters. — The function of the transmitters is to measure the required physical quantity (such as steam pressure and temperature, steam flow and water flow) and convert it into a small proportional electric current for transmission to the plant operating room by telephonic cable. Briefly, the principle of operation is that of the Evershed electronic repeater in which the current through a feed-back coil is adjusted until the force produced, in association with a permanent magnet, is equal to that caused by the physical quantity or condition being measured. These two forces are applied to a pivoted beam: any out-of-balance force causes contacts to be operated in the correct sense to vary the grid voltage (and the anode current) of a thermionic valve and therefore the feed-back current in the coil, until balance is restored. Once it has been set, the relationship between the output current and the measured condition is maintained and is not affected by changes in supply voltage or frequency, output circuit resistance or valve characteristics.

In some instances, as described below, the outputs from a number of transmitters are applied to a simple beam balance computer, the output of which follows a predetermined law. For example, the computer controlling the hydraulic coupling that regulates the output of the i.d. fan receives a signal proportional to the total fuel input to the mills and another signal proportional to the boiler combustion chamber pressure. The computer output is then converted to an operating force at the coupling by applying the current to the magnet of an oil-jet hydraulic actuator so that the requisite correction is applied to the i.d. fan drive, via the hydraulic coupling.

Three-Term Electronic Controllers.—The function of the three-term electronic controllers is to compare the transmitter signal with a preset value and to issue a three-term output, proportional to the deviation or error, plus the integral and derivative of the error, the three-terms being independent. This three-term output applies the appropriate adjustment to the positioner of the valve or damper. Controllers can be arranged for cascade operation as, for example, in the steam temperature control system described below.

Each controller consists of a "Miniplaque" which is mounted on the control panel and incorporates the proportional, integral and derivative settings, the measured value and controller output currents, the desired value and hand control settings, and an auto/manual changeover switch. The "Miniplaque" is connected by a twenty-five-core cable to the electronic component trays which are mounted in racks in a cubicle installed in a room just below the control room. These trays are all interchangeable

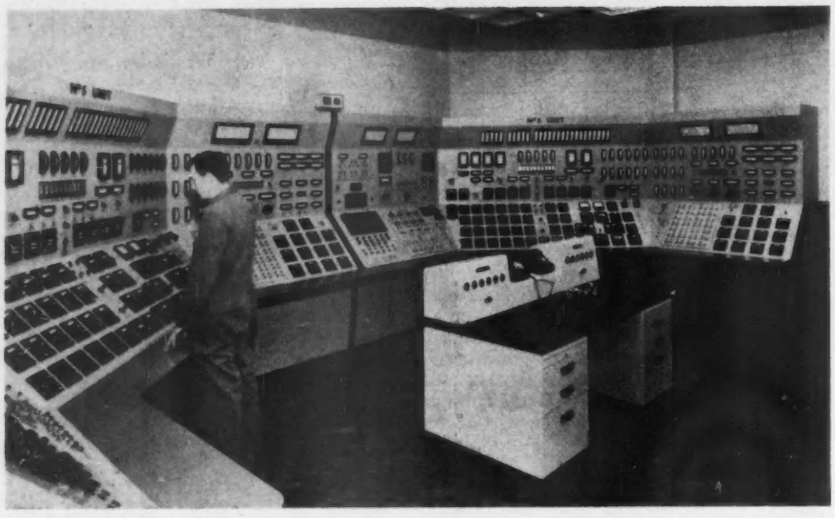


Two 60MW turbo-alternators in Little Barford "B" power station. The two boiler/turbine units are operated from the control room enclosure which can be seen on the left

and when a fault occurs the trays for that controller can be replaced to enable it to be put back into full operation.

Slave Cylinders or Positioners.—Each damper or valve forming part of the automatic control system is operated by an electro-hydraulic positioner which receives the current (0–15mA) sent out from the appropriate auto/manual control station or "Miniplaque." The positioner is self-contained, with its own electric motor-driven control oil pump and the case itself forms the sump for the control oil supply. The control current energises the coil of an electro-magnetic head which acts on one side of a hydraulic relay, the other side being restrained by a spring whose compression is adjusted by a cam in proportion to the position of the shaft and lever operating the damper. If the force due to the current does not equal that due to the spring, the hydraulic relay is deflected and causes the piston to move until the spring compression balances the current received from the control panel.

The system incorporates a hydraulic lock which operates in the event of a failure of control oil pressure, and prevents the positioner from moving. Manual operation is possible in these circumstances by moving the hand/automatic valve to the "hand" position, which equalises the pressure across the operating cylinder and allows the oil to pass from one side of the cylinder to the other. Each positioner is also equipped with a pressure switch whereby loss of control oil pressure causes a common alarm indication on the panel and lights a lamp associated with the appropriate auto-manual station.



Plant control room for the two 60MW boiler/generator units at Little Barford "B" power station

Master Control of Fuel Input Rate

Under the control of a master steam pressure transmitter, the rate of fuel feed to each boiler is determined by the steam pressure. The transmitter (type ER106) is designed to send out a signal ranging from 0mA to 30mA for a steam pressure change of 975 lb to 925 lb per square inch, the current falling with an increase in pressure. This current passes via the auto-manual control stations and minimum-load relays to the electro-hydraulic positioners operating the mill outlet dampers which regulate the rate of fuel input to the boiler. The minimum-load relays are arranged so that their output current is approximately 15 per cent greater than the input current so that, even if the latter falls to zero, a residual current will feed the mill outlet dampers, to prevent them from closing completely, Potentiometers vary the amount of shunting across the input coil of the appropriate minimum-load relay to enable the relative loading of the mill outlet dampers to be adjusted. The mill outlet dampers are arranged to close on control signal failure.

Mill Inlet Suction Control

For control of the inlet suction, each mill is provided with an ER.83 diaphragm-type pressure transmitter. Its diaphragm chamber is connected to a tapping point in the mill suction duct, the output current from this transmitter being linear to inlet depression. This output current is passed to the input circuit of a three-term controller, the output from which is received by the electro-hydraulic positioner regulating the mill inlet damper until the mill inlet suction has the value set by the controller. The mill inlet damper positioner is arranged so that, on failure of control signal, the positioner will close the damper.

Mill Outlet Mixture Temperature Control

A temperature transmitter (type ER.56) is installed in each of the two outlet ducts from each mill and is arranged to send out a current (0mA to 30mA) proportional to the temperature in the duct. One of these currents is selected to pass to the input circuit of the mill mixture temperature controller, the output of which is fed via an electrical relay to the electro-hydraulic positioner regulating the tempering air damper to maintain the mill mixture temperature at the required value. The electro-hydraulic positioner is arranged to open the damper on failure of the control signal. An interlock is provided between the mill mixture damper and the appropriate mill inlet damper so that whenever the latter closes, the tempering air damper closes as well. An LR.251 relay in the control line to the mill inlet positioner is set so that, when the control current to the mill inlet damper falls to, say, 3 per cent, a contact is made which will energise the relay and allow 15mA d.c. to be fed to the electro-hydraulic positioner operating the mill-tempering-air damper and will close the damper.

Combustion Chamber Pressure Control

Two type ER.83 diaphragm pressure transmitters are installed to measure depression in the furnace on the two sides of the boiler. One of the output currents from these transmitters is selected to pass to the input circuit of the combustion chamber pressure controller, the output from which passes via the i.d. fan computer and auto/manual stations to the electro-hydraulic positioners regulating the couplings on the i.d. fan. This i.d. fan computer also receives a signal from the total-fuel computer, the output from which is the sum of the currents sent to the electro-hydraulic positioners operating the four mill outlet dampers. As the rate of fuel input is roughly proportional to the opening of the mill outlet dampers, then this summated current is roughly proportional to the total rate of fuel flow. The equation for the i.d. fan computer is :

$$\text{Output} = \frac{M}{2} + 2C$$

Where M is the output from the total-fuel computer (0mA to 30mA) and C is the output from the combustion chamber pressure controller (0mA to 15mA).

In operation, the scoop tubes of the i.d. fan vanes are positioned roughly in relation to the amount of fuel entering the boiler ; this position is then trimmed by the combustion chamber pressure controller to restore the pressure to the required value. Thus, on a change in load, fuel and air flow change together and there is no delay between a change in heat input and the corresponding change in scoop tube position to give the same furnace depression at the new load. The coupling positioners of the i.d. fan drive are arranged so that, on a failure of control signal, the couplings move to maximum speed.

Steam/Air Ratio Control System

Two steam flow transmitters (type ER.91) are installed, one for each of the steam outlet mains, and are arranged to send out a current of 0mA to 15mA proportional to a change in steam flow of 0 lb to 325,000 lb per hour. These two currents are summated electrically by connecting the positive and negative terminals in their output circuits and this summated current passes to one coil of the air/steam flow ratio computer, the other coil of which is receiving the output current from the two air flow transmitters (type ER.109), measuring air flow in terms of differential across the venturis installed in the inlet ducts of the two f.d. fans. The output currents from the air flow transmitters are also linear to flow. The air/steam ratio computer follows the equation :

$$\text{Output} = 15\frac{(A-K)}{S}$$

Where A is the summated air flow current 0mA to 30mA. ; S is the summated steam flow current 0mA to 30mA ; K is a constant fed from a d.c. source.

The output current from the air/steam flow ratio computer passes via the air/steam flow ratio controller to the f.d. fan computer and the minimum load relay and then via the auto/manual stations to the electro-hydraulic positioners regulating the inlet vanes of the f.d. fans to maintain the air/steam ratio at the value set by the controller. The f.d. fan computer also receives the output current from the total fuel computer in a similar manner to the i.d. fan computer and has a similar equation. When the load changes the output current sent out by the total fuel computer roughly positions the f.d. fan vanes according to the new rate of heat input ; then

this position is trimmed by the air/steam ratio control to restore the ratio to the required value at the new load. The minimum load relay is arranged to send out a current which is up to 10mA below the input current, so that, since the f.d. fan vanes open on a failure in control current, the vanes can never close below a predetermined amount, which thus prevents extinction of the flame in the furnace.

Steam Temperature Control

Two steam temperature transmitters are provided, each connected to a thermocouple installed in the two outlet steam mains from the boiler. The currents sent out by these transmitters are linear to temperature and are summated electrically and passed to the input circuit of the steam temperature controller which will function with proportional plus integral plus derivative action.

To suppress any tendency to overshoot when coming up to load, the controller is provided with an integral limiting relay which ensures that the integral term of the controller does not become saturated even when an error has persisted, as will happen if the boiler has been running at low loads for a period.

The output current from the steam temperature controller passes to one coil of the steam temperature computer, the other coil of which is receiving the output from the air/steam flow ratio computer. The output from the steam temperature computer is equal to the arithmetical sum of these two currents and the equation of the computer is :

$$\text{Output} = T + (A - 15)$$

Where T is the output from the steam temperature controller (0mA to 15mA) ; A is the output from the air/steam flow ratio computer (0mA to 30mA).

The output current from the steam temperature computer is received by the attemperator water flow controller, the reset terminals of which are receiving the output current from the attemperator water flow transmitter. The output from this controller is passed to the electro-hydraulic positioner regulating the opening of the attemperator feed water control valve. The desired value of the attemperator water flow controller is determined by the value of the signals sent out by the steam temperature computer and the valve is adjusted by the attemperator water flow controller until the water flow determined by the value of this signal is obtained.

Any change in boiler load causes the current from the air/steam ratio computer to fall and (through the steam temperature computer) to call for an increase in attemperator water flow. After a short delay the steam temperature starts to rise slightly and the steam temperature controller output also calls for an increase in attemperator water flow ; but the air/steam ratio, during this period, tends to be restored to its previous value under the action of the air/steam ratio controller. The settings of the steam temperature controller and the steam temperature computer are such that, as the output from the air/steam ratio computer reverts to its normal figure, the output from the steam temperature controller rises so that the attemperator water flow remains at the increased value demanded by the change in air/steam ratio.

To prevent undesirable fluctuations in the steam temperature control during soot-blowing, a soot-blowing cut-out relay is incorporated in the output circuit between the air/steam flow ratio computer and the steam temperature computer. Normally this cut-out will be out of action and the full air/steam flow ratio current will be passed to the steam temperature computer. During soot-blowing, however, this switch will be moved to the "out" position, when the corresponding coil of the steam temperature computer will be short-circuited. If the soot-blowing cut-out is turned at a suitable speed no sudden movement to the feed water value will be produced, nor should there by any disturbance of the steam/air flow ratio control system.

A view of the plant control room is reproduced opposite. The "Miniplaques" are mounted on the control desks for No. 5 and No. 6 sets. An "in-line" scanner provides a quick means of detecting any departures from normal conditions.

Main Contractors

Civil Engineering Works.—Foundations and superstructure, The Mitchell Construction Company, Ltd. ; structural steelwork, Dawnays, Ltd. ; chimney, Bierrum and Partners, Ltd. ; cooling towers, Yorkshire Hennebique Contracting Company, Ltd. ; railway sidings, Thomas Summerson and Sons, Ltd.

Circulating Water System.—Circulating water pumps, Vickers-Armstrongs (Engineers), Ltd. ; c.w. make-up pumps, Sulzer Bros. (London), Ltd. ; screens, F. W. Brackett and Co., Ltd. ; c.w. pipework, T. B. Pearson and Sons, Ltd.

Mechanical Plant.—Boiler plant Nos. 5 and 6, Foster-Wheeler, Ltd. ; instrumentation and automatic boiler control, Evershed and Vignoles, Ltd. ; turbo-alternators Nos. 5 and 6, condensing and feed heating plant Nos. 5 and 6, C. A Parsons and Co., Ltd. ; turbine house crane, The Wharton Crane and Hoist Company, Ltd. ; boiler feed pumps, The Harland Engineering Company, Ltd. ; ash and dust plant, John Thompson Industrial Constructions, Ltd. ; high-pressure and low-pressure pipework, Stewarts and Lloyds, Ltd. ; reverse-cycle heat pump, Denco Miller, Ltd. ; service water tanks, Firth Blakeley Sons and Co., Ltd. ; water treatment plant, Permutit Company, Ltd. ; air compressor plant, Ingersoll Rand Company, Ltd. ; chlorination plant, Wallace and Tiernan, Ltd. ; coal handling plant, International Combustion Products, Ltd. ; Euclid motor scrapers, Blackwood Hodge, Ltd. ; diesel shunting locomotive, Andrew Barclay Sons and Co., Ltd.

Electrical Plant.—Generator transformers, C. A. Parsons and Co., Ltd. ; auxiliary transformers and station transformer, Bryce Electric Construction Company, Ltd. ; 3·3kV switchgear and 415V switchgear, English Electric Company, Ltd. ; 132kV switchgear and alternator main connections, A. Reyrolle and Co., Ltd. ; 132kV cables, W. T. Glover and Co., Ltd. ; 11kV and lower voltage cables, London Electricity Board ; station lighting and plug point installation, Central Electric Company, Ltd. ; station batteries and charging equipment, Chloride Batteries, Ltd. ; plant control room, unit control consoles, Evershed and Vignoles, Ltd. ; electrical control room panels, A. Reyrolle and Co., Ltd. ; fire-fighting installation, Mather and Platt, Ltd.

Some Early Oil-Engined Locomotives

(*Contributed*)

In a report on the Priestman oil engine dated March 7, 1888, Sir William Thompson (afterwards Lord Kelvin) mentions that "a small double-cylinder engine has been mounted upon a truck, which is worked on a temporary line of rails to show the adaptation of a petroleum engine for locomotive purposes." This appears to be the first instance of the use of a heavy-oil engine for rail traction. It may even be the first application of an internal combustion engine on a railway vehicle. Later (in 1894) Priestman Brothers built a four-wheeled shunting locomotive for standard gauge track, this locomotive being fitted with a Priestman 30 b.h.p., two-cylinder, double-acting, vertical oil engine, speed 300 r.p.m. The locomotive was used for shunting trucks at Hull and must have been developed from the equipment mentioned by Lord Kelvin in his 1888 report. Eighteen years after the appearance of the 30 b.h.p. Priestman locomotive came the Klose locomotive—planned by Adolf Klose and Rudolf Diesel—in which a four-cylinder Sulzer two-cycle engine built in "V" formation and giving an output of approximately 1000 b.h.p. was incorporated with a chassis, running gear, &c., manufactured by A. Borsig, of Berlin-Tegel, the main contractors being Sulzer Brothers. In this locomotive the connecting-rods of each opposite pair of cylinders actuated a single crank, there being two cranks arranged at 180 deg. The two-throw crankshaft had disc cranks at each end, these driving the coupling rods connecting the two driven axles, the locomotive having four-coupled driving wheels and a four-wheeled bogie truck at each end. With a total weight of 95 tons the designed maximum speed was 100km per hour (62·14 m.p.h.), which required an engine crankshaft speed of 304 r.p.m. This was the first serious attempt to utilise a diesel engine in a main line locomotive, and during 1912 it was subjected to extensive preliminary road tests in Switzerland. Later, on the Prussian State Railways, the results in actual traffic were not such as to justify perpetuation of the design. The troubles experienced were due mainly to difficulties in starting and in ensuring continuous firing at low speed. Protracted trials demonstrated the imperative need, in the case of a diesel locomotive, of a transmission and speed-adjusting system between the engine crankshaft and the rail wheels.

Among the engineers who studied the Sulzer-Klose locomotive in 1912 was the Swiss engineer, Dr. Hermann Lemp, who settled in the United States and entered the service of the General Electric Company. Lemp received grant of a patent covering a control system for electric transmission on locomotives, which appears to be the parent of nearly all the control systems now in use on diesel-electric locomotives. As a result of his observation and researches, Lemp (who died as recently as 1954 at the advanced age of ninety-two years) recommended the General Electric Company to take up, in the first place, gas engine-electric and later (in 1922) diesel-electric traction equipment.

A further stage in the evolution of oil engine traction was reached during 1923, when an agreement was made between the German and Russian railways to collaborate in the development of a series of three diesel locomotives, the designs for the first two of them being made by Professor G. V. Lomonossoff. In 1924, the first of the two locomotives (of diesel-electric type) was completed, the diesel engine being built by the Maschinenfabrik Augsburg-Nürnberg ; the electric generator by Brown Boveri, and the chassis parts by Hohenzollern A.-G., Düsseldorf. The diesel engine was of four-stroke submarine type with six cylinders, full-load output 1200 b.h.p. at 450 r.p.m. Tests made in the locomotive laboratory at Esslingen showed an overall efficiency of from 25·3 to 27·4 per cent. At the end of 1925 there was completed the second of the three locomotives designed by Lomonossoff, this being fitted with an engine (M.A-N.) identical with the one supplied for the first locomotive. The transmission, however, was by a system of mechanical gearing and electromagnetic clutches, this gearing being supplied by Fried. Krupp A.G., Essen, the chassis parts again coming from Hohenzollern A.-G., Düsseldorf. Tested at Esslingen and on the German railways during 1926, the locomotive was delivered to the Russian railways in 1927. The third locomotive of this series was completed during 1930 the power unit being once again a six-cylinder, four-cycle M.A-N. submarine engine of 1200 b.h.p., as fitted in the diesel-electric and diesel-mechanically geared equipment. In the third locomotive, however, the transmission was pneumatic, the diesel engine being coupled to a reciprocating air compressor of vertical type, the air being used in the cylinders of the locomotive after the manner of the normal steam locomotive. The wheel arrangement was 4–6–4 and the chassis parts were manufactured at Esslingen. Experimental work on the pneumatic transmission began some five years before the completion of the locomotive, the designers of which were Dr.-Ing. Max Mayer and Dr.-Ing. Geiger. It must be mentioned that the idea of pneumatic transmission is an old one, possibly the first description of it being given in a patent granted during 1844 to John William Buckle Reynolds, who proposed a gas-engine-driven air compressor for the propulsion of vehicles.

In later applications of pneumatic transmission considerable pioneer work was carried out in Italy by Zarlatti and by Ansaldo, and in Great Britain by Dunlop and others.

Prior to the appearance of the Esslingen-built diesel-pneumatic locomotive, there had been completed in 1927 the Kitson-Still locomotive in which the six-coupled wheels of a 2–6–2 locomotive were driven through jack-shaft from a horizontal, four-cycle, eight-cylinder *vis-à-vis* direct-injection oil engine of crosshead construction working on the Still principle, steam being raised in a boiler partly heated by the exhaust gases of the oil engine. The designed maximum engine output at a speed of 450 r.p.m. (working as oil engine only) was 1000 i.h.p., this crankshaft speed giving a locomotive speed of 45 m.p.h. The weight of the Kitson-Still locomotive in working order was 70 tons. Exhaustive trials did not produce results sufficiently promising to justify further development of the design. Two years after the completion of the Kitson-Still locomotive there was placed in service on the Canadian National Railways (1929) what has been referred to as the " Beardmore-Westinghouse " locomotive. This was built by the Canadian Locomotive Company from plans made by the Baldwin Locomotive Works, the entire equipment being produced under the supervision of the Westinghouse Electric and Manufacturing Company, who constructed the electrical portion. The engine was a twelve-cylinder, six-crank, four-cycle, direct injection " V " type engine, the normal full-load rating being 1340 b.h.p. at 800 r.p.m., with a maximum output of 1500 b.h.p. at 900 r.p.m. Two of these engines were built, each of them being fitted in one unit of an articulated diesel-electric locomotive consisting of two similar self-contained units, each equipped with its own generator for supplying four traction motors, one to each driving axle.

It was in 1933 that the Chicago Burlington and Quincy Railroad ordered from the Electro-Motive Division the 600 h.p. equipment with two-cycle engine for what was to prove the first successful diesel-electric-powered main line motor train in the United States, a train which, on May 26, 1934, ran from Denver to Chicago, 1015 miles, in 13 h 5 min, average speed 77·6 m.p.h.

U.K.A.E.A. Computer Section at Risley

A COMPUTER section which is stated to form the largest general-purpose computing centre in Europe is one of the facilities provided by the Central Technical Services group at the Risley establishment, near Warrington, of the United Kingdom Atomic Energy Authority's Development and Engineering Group. The D. and E. group has seven branches, one of which is Research and Development. It is this branch which provides the Central Technical Services at Risley, comprising sections dealing with nuclear problems for thermal and fast reactors, mechanical engineering, chemical engineering and computing. Close consideration was given to the economies which could be achieved by large-scale computing and to evolving an organisation enabling the facilities to be used with maximum effect. The procedure is for a member of the nuclear design staff first to contact the section and individual in Central Technical Services dealing with the subject on which he is seeking assistance. Sometimes an answer will be produced without calling on the computer section, but if the use of heavy computing machinery is obviously required, the section of C.T.S. which has been called in would not itself go beyond a mathematical formulation of the problem. This would then be passed to the programmers in the computer section and so finally reach the machines. The concentration of the programmers and computers in one section is called a " closed shop " system and is considered advantageous in relieving other sections of C.T.S. from the programming work itself.

The equipment of the computing section comprises two digital computers (a Ferranti " Mercury " and an I.B.M.704) in the mechanical engineering subdivision and a " PACE " analogue computer of Electronics Associated, Inc., for those problems which can only be negotiated by observing the effects of various methods of approach and, from these observations, deciding on the next steps to be taken. In addition to the computers, hand calculating machines are available for simple problems. The computer section occupies a floor area of 15,000 square feet and has an electrical consumption of 400kW. It has been brought into use in stages over the past year, the last machine commissioned being the I.B.M.704 in October, 1959. The machines are working on a shift system, and the shifts are to be increased to 120 hours a week. Staff of the computer section includes twenty-eight programmers, eight engineers (of whom five are employees of International Business Machines), and four machine operators.

The " Mercury " computer uses punched tape input and output, and the I.B.M.704 takes punched cards. Both machines have magnetic core " memories," supplemented in the " Mercury " by a magnetic drum backing store and in the I.B.M. by ten magnetic tape units. In the " Mercury " computer the high-speed store can accommodate up to 1024 words of forty binary digits and the backing store 16,384 such words. The I.B.M.704 will hold 32,768 items in the magnetic core store and 10,000,000 in the magnetic tape units. A data transmission link using the " Mufax " facsimile equipment of Muirhead and Co., Ltd., is provided between Risley and Harwell in order to enable staff at A.E.R.E. to make more effective use of the I.B.M.704 machine. Punched card information, results and programme modifications can be transmitted very rapidly by this medium, and a similar link will be established shortly between Risley and Winfrith Heath. Experiments are also being made in the remote control of the I.B.M.704.

The " PACE " computer is designed for operation on a frequency of 60 c/s, and during an inspection of the computing section last week we were shown the 150kW motor-generator set installed for frequency conversion. This set, supplied by the Brush Electrical Engineering Company, Ltd., consists of a synchronous-induction motor driving a 430V alternator and is required to maintain the frequency within ± 1 c/s. The 208V supply to the computer has to be held within ± 2 per cent, and for this purpose the exciter is controlled by an Isenthal vibratory regulator.

An air conditioning plant is required for maintaining the I.B.M. room at a temperature of 70 deg. Fah., with controlled humidity : 90 per cent of the air is recirculated after chilling by water spray. In addition to the water pumps and air-circulating fan for the I.B.M. plant, the air-conditioning room houses a 600 c.f.m. blower for cooling the " PACE " computer.

Calculations and studies carried out in the computer section may be applied either to the design of a nuclear reactor or to its operation. A major design problem exists in the choice of a reactor specification which would lead to the lowest cost of electricity. It has been estimated that a 1 per cent decrease in cost of electricity from a 1000MW system, attained by accurate optimisation of the many variables which may be examined by computing processes, would pay for the Risley computers over a period of six years.

"PACE" analogue computer in the Risley computer section

Programmers setting up patch panels for "PACE"

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Scientific Satellite

IT will be recalled that last year a number of Chance Vought "Scout" satellites were offered by the United States National Academy of Sciences and N.A.S.A. to this country to act as vehicles for experiments in space science. (See page 42, August 7, 1959.) The first satellite concerned, which will be styled "International I," is expected to be launched from the N.A.S.A. facility at Wallops Island, Virginia, scene of free flight model testing by the N.A.C.A. The experiments destined for this first satellite are described in a statement issued by Professor H. S. W. Massey and abstracted below.

Proposals for six experiments were agreed by the British National Committee on Space Research in December, 1959, and formally approved by the Steering Group on Space Research a little later. The proposals were then forwarded to N.A.S.A. and C.O.S.P.A.R. The appropriate Working Group of the latter body reviewed them at its recent meeting at Nice and reported favourably on them as constituting a valuable set of scientific experiments.

On January 20, 1960, a party consisting of Professor H. S. W. Massey, Dr. A. P. Willmore and Dr. H. Elliot, met with representatives of N.A.S.A. in Washington to discuss the desirability and feasibility of the experiments, and to set up the appropriate organisation for carrying out the task of providing the fully instrumented satellite package.

Complete agreement was reached about the suitability of the experiments and the practicability of including them in a "Scout" satellite. The constitution of the Working Group responsible for the design, construction and testing of the satellite package was agreed. Mr. M. O. Robins will be the manager of the group in the United Kingdom, responsible for co-ordination both within the U.K. and with the American manager. In addition to the launching of the vehicle and the construction of the satellite shell, the Americans will be responsible for the provision of temperature control within the package and for data transmission. The target date of launching is in the latter part of 1961. The launching site will be on the east coast of the United States and the orbit will pass over this country.*

The choice of the final British scientific experiments to be included in a "Scout" satellite took account of a number of factors. It was necessary that most of the scientific groups concerned should have had experience in the "Skylark" programme, so that most of the experiments would be appropriate modifications of similar investigations in that programme. A further important consideration was that an experiment should not mainly duplicate work already done by United States and Soviet scientists but should take advantage of any special experience possessed in this country.

A natural choice for the "core" of the experimental programme was the direct study of the electrical properties of the ionosphere. This region extending outwards from a height of 60 miles to several hundred miles, makes long-distance transmission of radio waves possible. Sir Edward Appleton, F.R.S., was a pioneer in the study of the ionosphere from the ground and ever since that time British scientists have played a leading part in this work. New opportunities of wide scope are offered by the availability of satellite vehicles capable of conveying instruments through the ionosphere. Two research groups, one under Professor Sayers at the University of Birmingham and the other under Dr. R. L. F. Boyd and Dr. A. P. Willmore at University College, London, have been developing the techniques for laboratory study of ionised gases like the ionosphere for some years. Both groups have applied the experience gained in this way to carry out with success, ionospheric observations with instruments in "Skylark" rockets. Three of the experiments in the first "Scout" vehicle are based on these earlier investigations.

In one set of experiments, Dr. Boyd's group will measure the concentration and mean energy of the electrons in the ionosphere. From the mean energy the temperature may be determined.

The same group will also determine the nature of the positively charged atomic fragments (positive ions) in the ionosphere. This is designed to follow the variation in composition of the high atmosphere, presumably mainly atomic oxygen, as it merges into interplanetary space in which the main constituent is hydrogen.

Professor Sayer's group will measure the electron concentration by a quite different method, so that a most valuable check can be made with the results obtained with Dr. Boyd's technique.

The ionosphere is subject to control by the sun and it is therefore most desirable to observe simultaneously with the properties of the ionosphere the intensity of the solar radiation which is influencing it. Dr. Boyd's group are therefore including equipment in the form of suitable counters to measure the intensity both of the X-rays and of certain ultra-violet radiation from the sun.

Finally, an experiment is to be included which is designed to measure the intensity of the heavy component of primary cosmic rays. This will be the responsibility of Dr. Elliot's group at Imperial College, London, who have carried out many important ground-based studies of cosmic radiation in the past. Observations of cosmic rays from satellites are now known to be complicated by the presence of the Van Allen radiation belts but there is no difficulty in providing counter equipment which will distinguish the heavy component of cosmic rays from the particles present in these belts. Dr. Elliot hopes to obtain information about the nature of the magnetic field experienced by the cosmic rays.

* The highest latitude reached will be that of Edinburgh.

Laboratory Measurements on Einstein's Theory

AT a Press conference in London on January 30 it was stated that a small group of scientists in the nuclear physics division of the Atomic Energy Research Establishment, Harwell, had carried out experiments indicating that a hitherto unconfirmed prediction of Einstein's General Theory of Relativity appears to be correct. The experiments were reported at a meeting of the American Physical Society on the same day. In the first experiment the effect of gravitational fields on electromagnetic radiation (the so-called "red shift") was measured and the results were compared, in the second experiment, with the effects of accelerations on the same kind of radiation. These two experiments, taken together, constitute an illustration of the Principle of Equivalence which is the basic premise of Einstein's General Theory of Relativity.

It may be recalled that Einstein first predicted the red shift in 1907 and then derived the complete theory in 1911. Since then astronomers have been searching for evidence for this red shift in the spectral lines observed in light from the sun and other stars that have very strong gravitational fields. But, while many observations show a shift of some sort, the results are not conclusive : some of the shifts observed are much larger than predicted by relativity and some much smaller. It is generally accepted to-day that, since there are many effects other than gravitation which can give rise to stellar shifts, the evidence for a gravitational red shift from astronomical measurements is ambiguous.

The Harwell experiments made use of a recent discovery by a German physicist, Dr. R. L. Mössbauer, of the Technische Hochschule in Munich. He found that, under certain conditions gamma rays (very short wavelength electromagnetic radiation) are emitted with an extremely precise energy. He established this fact by allowing gamma rays from an isotope of iridium to be reabsorbed by other iridium nuclei. When he moved the emitting nuclei towards or away from the absorbing nuclei, with velocities of about a fraction of an inch a second, he found that the absorption no longer took place. This result he attributed to a very small shift in the energy of the gamma rays caused by the Doppler effect. By studying the shape of the absorption as a function of velocity he traced out the shape of the resonance line and found the effective width to be one part in 10^{11} of the energy of the gamma ray. It followed that these gamma rays might be used as an extremely precise tool, by physicists in various measurements.

The potential usefulness of this technique as a test of the General Theory of Relativity became apparent to physicists at Harwell when they discovered that an isotope of iron called Fe^{57} showed an effect similar to the one reported by Mössbauer, except that the absorption was fifty times stronger and the line width a hundred times narrower. The width of the line was approximately one part in 10^{13} while the shift expected from Einstein's theory for a height of 25ft in the gravitational field of the Earth is one part in 10^{16}.

Using a water tower at Harwell, three physicists, Dr. T. E. Cranshaw, Dr. J. P. Schiffer and Dr. A. B. Whitehead, placed a radioactive source emitting the gamma rays of Fe^{57} at a height of 40ft. The gamma rays were allowed to pass through an evacuated tube and then through an absorber of Fe^{57} nuclei below. By careful measurement of the shift of the resonance line they observed a displacement which corresponds to $0{\cdot}95 \pm 0{\cdot}43$ times the effect predicted by Einstein. This implies that the probability that there is no red shift is less than one part in sixty. A similar experiment is being performed by Professor Pound and Mr. Rebka at Harvard University. Experiments are also in progress at Manchester University, using Zn^{67}.

Now the Principle of Equivalence postulated by Einstein states that there should be no detectable difference between a uniform gravitational field and acceleration. It would follow that people completely enclosed in a space ship, with no way of obtaining information from the outside, could not tell from any measurement made inside the space ship whether they were sitting at rest in the gravitational field on the surface of a planet or whether their space ship was accelerating. To test this statement fully, a second experiment was performed by another A.E.R.E. physicist, Dr. H. J. Hay, in collaboration with Drs. Schiffer and Cranshaw. They placed a radioactive source at the centre and an absorber at the outside surface of a cylindrical rotor. By spinning the rotor up to velocities of 30,000 r.p.m., they could obtain accelerations up to 65,000 times as large as the acceleration of gravity on the surface of the Earth. Observing the variation of the number of gamma rays passing through the absorber at different speeds of rotation, they could again test Einstein's premise. They observed, for the first time in an accelerated system, the effect predicted by Einstein, and thus they conclude from their experiments that accelerations appear, indeed, to be equivalent to gravitational fields.

The radioactive source for this experiment was prepared in the University of Birmingham cyclotron by bombarding an iron target for 100 hours with a beam of deuterons. The source was purified at the Radiochemical Centre at Amersham. The final processing of both the

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source and the absorber was performed at the Chemistry Division of A.E.R.E.

In the next few months the members of the Harwell team hope to repeat their measurements with greatly improved accuracy to give added weight to their conclusions.

Reports on Machine Tools

THE following statement has been received from the Machine Tool Trades Association.

The machine tool industry, through its trade association, the Machine Tool Trades Association, feels that a considerable amount of harm is being caused to its export potential by the continued unjustified comment which has been current in various circles in the recent past.

There has been considerable talk of three "reports" on the industry and it has been suggested that their non-publication must of necessity indicate a sad state of affairs in this industry, which is only now being recognised outside its own ranks as basic to the country's needs. Taking these three reports in turn :

The Department of Scientific and Industrial Research Paper.—The genesis of this paper was D.S.I.R.'s need to be provided with information on the research and development needs of industry as part of the background to its own programme. It was compiled with the fullest co-operation of the machine tool industry, many of whose constituents provided confidential technical information which, if made available to any other manufacturer at home, and more especially abroad, would undoubtedly confer considerable disadvantage upon the companies concerned in their forward development programmes.

As has been announced, discussion of the paper between industry and D.S.I.R. has been continuous since its production and has enabled the Association to formulate proposals for consideration by its members for further efforts in the research field to supplement the considerable volume of research currently in progress in individual firms and groups and in research centres. This consideration will be crystallised at a series of regional meetings in February.

The Melman Report.—This report, commissioned by European Productivity Agency, is not concerned with any individual machine tool manufacturing country in Western Europe—and perhaps less with the United Kingdom than any other, in that Professor Melman, so far as members of this Association are aware, did not include any machine tool manufacturers in his one-week visit to the U.K. during his tour of Europe, on which his report is based. It would appear, therefore, that he has no recent first-hand knowledge of the U.K. machine tool industry. That is not to say that his report ought to be lightly dismissed and the Association welcomes the establishment of a sub-committee of the Machine Tool Advisory Council to examine his findings.

Publication of his report must surely be determined by the authority commissioning it—E.P.A.

N.P.A.C.I. Report.—This report again is a document prepared for a body, which alone must be responsible for its publication or non-publication. The Association, not being represented on the National Production Advisory Council for Industry, is not in a position to comment on whatever may be the contents of this report. It is known, however, that apart from bringing statistics up-to-date, it contains nothing which the M.T.T.A. itself has not already freely published, or offered for publication.

The industry itself has been well aware of the intensification of competition in all the world markets over recent years and has not allowed any course to meet that competition to remain unexamined. It was, for example, among the van of those who pressed for the elimination or reduction of the so-called "Strategic Embargo List," the reduction of which opened additional markets. Its participation at the Leipzig Fair was marked by the immediate purchase of a greater part of its exhibit than was accorded any other participating Western country and has been followed by several repeat orders. A mission to Spain early in 1959 found itself frustrated only by economic considerations and not on technical grounds. And there are many other examples in the commercial field.

Technically, the industry is also well aware of its responsibilities—to continue to meet these it has, for example, established its own Design Scholarship at the Manchester College of Science and Technology, where ten scholars are currently studying and ten more will start their course in October, 1960.

Together with the further meetings on research activity which have been arranged, it is anticipated that the industry will continue to fulfil its obligations to the country.

Sizewell Nuclear Power Station, Suffolk

WE learn from the Central Electricity Generating Board that the Minister of Power has given his consent to the building of a nuclear power station at Sizewell, Suffolk. With a planned output of 650MW, larger than any of the nuclear stations now under construction, the Sizewell station will help to meet the rising demand for power in Suffolk, Norfolk and adjoining areas. The Sizewell site comprises just over 200 acres of land, none of which is of high agricultural value, and the area is sufficient to permit extension of the station if required in the future.

In an area where unemployment is still a matter of concern, a labour force of 2000 men will be needed for the building. When completed in 1965, a staff of about 400 will be required to operate the station. The development will provide an addition of about £150,000 to the rateable value of the area when the station is fully operational.

The East Suffolk County Council granted planning permission for the station in April, 1959, and has co-operated fully with the C.E.G.B. during the initial investigation and subsequent negotiations. Tenders are being sought forthwith from the consortia of companies engaged in nuclear power station construction work, and preparatory work will be carried out on local access road improvement.

It will be recalled that four nuclear power stations are at present being built by the Central Electricity Generating Board at Bradwell, Essex (300MW) ; Berkeley, Gloucestershire (275MW) ; Hinkley Point, Somerset (500MW), and Trawsfynydd, Merionethshire (500MW).

The C.E.G.B. has received consent for a fifth station, at Dungeness, Kent (500MW) and consent is being sought for a 1000MW station at Oldbury, Gloucestershire.

The South of Scotland Electricity Board is building a 300MW nuclear power station at Hunterston, near Ardrossan, Ayrshire.

Institute of Refrigeration Dinner

ON Wednesday, January 27, the annual dinner of The Institute of Refrigeration was held at the Savoy Hotel, London, and this year celebrated the diamond jubilee of the founding of the Institute. Viscount Simon, chairman of the Port of London Authority, proposed the toast of "The Institute of Refrigeration," and had something to say about the history of refrigeration. He recalled the arrival of the first refrigerated cargo in 1880 and the building of the first store in 1881, equipped with machinery built by J. and E. Hall, Ltd., by the London and Saint Catherine Dock Company while a rival company refitted old ships as refrigerated hulks. The rapid increase in the capacity of storage space since the turn of the century was noted, as were the other industries in which refrigeration is of increasing importance. During its sixty years of existence many developments, he continued, had been greatly assisted by the Institute, which formed a bridge between the scientists and the refrigeration engineers. In the course of his reply the president, Sir Rupert de la Bere, informed the members that the National College would be complete by September and thanked those who had helped financially. Sir Rupert also announced that Commander W. R. Sinclair had been elected by the Council to be the next president.

St. Lawrence Seaway

PRELIMINARY traffic statistics issued by the Canadian and United States authorities for the St. Lawrence Seaway show that 20,100,000 tons of cargo were carried through the Seaway (Montreal-Lake Ontario) in the 1959 navigation season. This figure is 8,300,000 tons, or 71 per cent, in excess of the quantity of cargo carried by the old St. Lawrence canals in 1958. The upbound movement increased by 6,150,000 tons (132 per cent) and the downbound by 2,180,000 tons (31 per cent). Bulk cargo (as defined by the tariff) was 91 per cent of the total. The figures are subject to revision.

Cargo transported through the Welland canal to the end of navigation totalled 26,900,000 tons, which was 27 per cent greater than the 1958 traffic. Of this total, 16,278,400 tons was "downbound." Upbound movement increased by 92 per cent and downbound by 6 per cent.

By the end of navigation last year, 6676 vessels had passed through the St. Lambert lock, either upbound or downbound. Through passages on the Welland canal for the same period numbered 7866.

High-Pressure Lubricant Pump

A PEDAL-OPERATED dispenser for heavy lubricants such as Shell "Cardium" D and Mobil "Dorcia" 150 has been evolved by Centralube, Ltd., Eley Estate, London, N.18. This pump, the "Hercules," can generate a maximum pressure of 15,000 lb per square inch ; it is normally provided with a special fitting to engage with a Centralube distribution system, with which a plurality of points can be lubricated simultaneously. The high pressure can be exploited to clear blockages by using normal lubricants. The delivery depends on the consistency of the lubricant, and for a grease of penetration 250 is 2·3 grammes per stroke. After every twenty to forty strokes, a handwheel must be turned to force the grease from the reservoir to the pump proper. The complete pump weighs 50 lb, and can be rolled on two wheels.

[Reply Card No. E2325]

Nuclear Propulsion of Ships

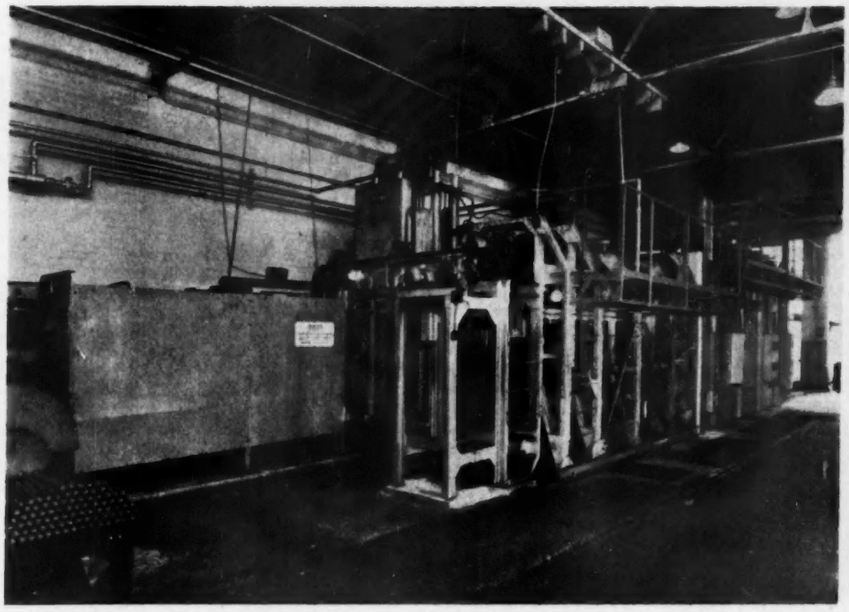
IN a written answer to a question in the House of Commons, Mr. Marples, the Minister of Transport, stated that invitations to tender for a reactor for installation in a ship to serve as a prototype in marine propulsion, would be sent to the following firms and consortia : A.E.I.–John Thompson Nuclear Energy Company, Ltd., which is now part of the Nuclear Power Group, Babcock and Wilcox, Ltd., The English Electric Company, Ltd., Hawker Siddeley Nuclear Power Company, Ltd., and the Mitchell-Fairfield-Combustion Engineering Nuclear Power Consortium.

Tidal Flow Computations

AN error occurred in the third column of page 180 in the printing of the article "Tidal Flow Computations" in the Technical Contributors Section of our issue of January 29. Equation 22 should have read as follows :

$$\bar{h}=\underline{h}+\frac{\Delta t}{\Delta x}\cdot e^{\frac{K\Delta x}{2}}\,|h\,.\,|u-\frac{\Delta t}{\Delta x}\cdot e^{\frac{-K\Delta x}{2}}\,h|\,.\,u|$$

Our apologies are due to the authors and to readers confused by the error.



Front of the furnace with the pusher mechanism into the hardening section on the left, and the tempering furnace line on the right

Automatic Hardening and Tempering Furnace Installation

AN automatic continuous hardening and tempering furnace for the treatment of carbine barrel forgings has been supplied by G.W.B. Furnaces, Ltd., Dudley, Worcs, to the Royal Ordnance Factory at Fazakerley. This installation includes two pusher type furnaces, one for hardening and one for tempering, each furnace being equipped with a quenching and de-greasing plant ; and the hardening furnace having an associated protective atmosphere plant. The installation is set out in the form of a U, of which the hardening furnace with its quench tank and de-greaser form the first leg and the tempering furnace equipment forms the second leg, the legs being connected at the lower end by a cross-transfer track. A cross-transfer track at the head of the installation, and to be seen in our illustration, is used for loading and unloading the work from jigs which carry the barrel forgings through the furnaces.

Each of the jigs used carries eight suspended forgings and each loaded jig in turn is conveyed automatically under the pivoted head of the hardening furnace hydraulic pusher which conveys the carriers separately into the hardening furnace. The hardening furnace has an effective heated length of 13ft 4in, a width of 9in, and a height of 3ft 3in, its rating of 120kW being arranged in two independent automatically controlled zones, giving a maximum temperature of 900 deg. Cent. The normal operating temperature is 850 deg. Cent., with soaking times of one to one and a half hours, and the unit is designed for a nominal consumption of 73kW per hour at 850 deg. Cent. Two rows of skid rails support the charge carriers during their passage through the furnace, and heavy section 80/20 nickel-chromium strip heating elements are arranged on the side walls of the chamber. At each end of the furnace is an electrically-operated fully-insulated counterbalanced door. A gas-lock chamber is situated at the entrance of the hardening furnace, whilst at the exit is fitted a gas-tight quenching hood, the bottom edges of which are immersed below the level of the quenching medium.

As the pusher propels the line of carriers through the furnace, an extractor gear is timed to remove the innermost carrier from the furnace chamber on to the platform of a quenching hoist. The platform then automatically lowers and places the carrier on to the quench conveyor, which conveys the charge through the quenching medium and also through the de-greasing unit. In this gas-heated de-greasing unit, the barrels are sprayed with de-greasing solution from a battery of fixed jets.

A second extractor gear then removes the charge carrier from the quench conveyor and transfers it on to a traversing conveyor, by which the carriers are conveyed across into the tempering furnace line. At the tempering furnace line, the charge carrier is pushed from the conveyor into the tempering furnace by a second pusher gear. The tempering furnace has a heated length of 20ft, and a rating of 90kW in three independent automatically controlled zones. Different types of forgings are soaked for periods ranging from one and a half to three hours at temperatures up to 650 deg. Cent. Four air circulating fans are situated in the furnace roof, and baffles of heat-resisting alloy are specially situated to give directional air flow over the heating elements and through the working space. The quenching and de-greasing arrangements of the tempering furnace, together with the extractor and conveyor systems, are similar to those in the hardening furnace line so that a continuous conveyor system is formed, linking all operations.

Automatic temperature control for both furnaces is provided by a common instrument control panel. A complete sequence of operations for the installation is carried out automatically, and all the necessary limit switches and similar interlocks are controlled from a master sequence time switch in the instrument control panel. The protective atmosphere plant is a standard G.W.B. burnt town's gas exothermic unit having a capacity of 1000 cubic feet per hour, and linked with a silica gel gas drying plant.

[Reply Card No. E2331]

Continuous Heat Treatment Plant for Rollers

WE illustrate below an automatic heat treatment plant designed and built by the Electric Resistance Furnace Company, Ltd., Queens Road, Weybridge, Surrey, for the works of British Timken, Ltd., at Daventry. It is designed for a minimum throughput of 100 lb of ¾in diameter rollers an hour, including a soaking period of one hour. Depending upon the size to weight ratio of the product treated, an output of some 300 lb per hour can be attained with the installation.

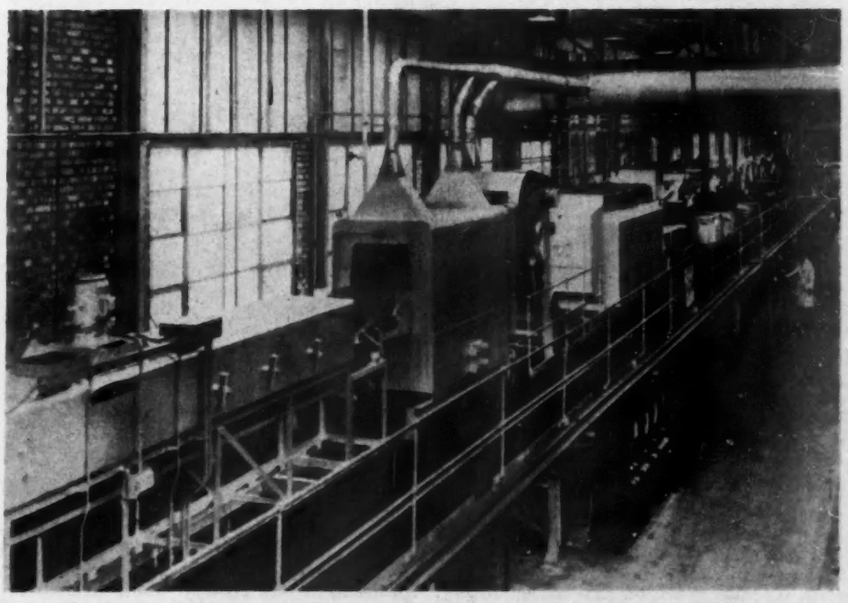
Rollers to be heat treated are carried by an electric elevator into a hopper which feeds them on to the oscillating hearth of the hardening furnace. This hearth is 18in wide and is actuated in one direction by an electric motor driving an operating cam, and in the other direction by a spring return mechanism. The hearth furnace provides temperatures up to 950 deg. Cent., and has a total rating of 63kW. It is supplied with a controlled atmosphere, produced in an " Efco " generator by the endothermic process, to keep the rollers free from decarburisation.

The rollers enter the furnace chamber through a short vestibule fitted with a fume removal hood and having a vertically rising door. The 8ft long chamber of the furnace is heated by electric radiant tubes, arranged in three zones, and positioned above and below the hearth.

From this furnace the rollers are discharged directly on to a chute on which they are immediately quenched in an oil weir. The oil pumped to this weir travels with the rollers into the quench tank, from which they are carried by the perforated steel belt of an elevator into a washing machine where the oil is removed by a hot detergent spray. The cleaned rollers are then delivered by a wire-mesh conveyor belt down a chute and distributed by guide rails on to the conveyor of the tempering furnace.

In the 20ft long chamber of the tempering furnace the rollers are heated by fixed circulation of air from heater tanks of nickel-chromium wire spirals mounted on frames in the roof. This furnace is rated at 50kW and normally operates at 160 deg. Cent., although it can operate at up to 300 deg. Cent. if required.

[Reply Card No. E2332]



Feed end of automatic continuous heat treatment plant for bearing rollers

SHORTER REPORTS *(Continued)*

Lloyd's Register Shipbuilding Returns

THE Shipbuilding Returns for the fourth quarter of 1959 have been published by Lloyd's Register of Shipping and show that in Great Britain and Northern Ireland the work in hand included 276 steamships and motorships of 2,032,600 tons gross, the lowest figure since June, 1956. During the quarter sixty-two ships of 318,305 tons were commenced, eighty-six ships of 441,596 tons were launched, and seventy-eight ships of 402,640 tons were completed. Oil tankers included in the total work in hand amounted to sixty ships of 986,796 tons or 48·5 per cent. Tonnage for registration abroad totalled thirty-three ships of 259,119 tons or 12·7 per cent of the tonnage being built and compares with the peak export figure of 825,745 tons or 40·4 per cent reached in September, 1950. Abroad, excluding Russia, China and East Germany, the total under construction was 1153 ships of 7,549,983 tons gross and during the quarter the totals commenced, launched and completed were respectively; 427 ships of 1,933,842 tons, 410 ships of 1,849,446 tons, and 441 ships of 2,121,255 tons. Oil tankers under construction totalled 210 ships of 3,884,073 tons gross representing 51·4 per cent of the total tonnage being built abroad. The tonnage building for export amounted to 3,384,683 tons or 44·8 per cent. Throughout the world, 1429 ships of 9,582,583 tons gross were under construction, of which 21·2 per cent were being built in Great Britain and Northern Ireland. Included in the total were 270 oil tankers of 4,870,869 tons or 50·8 per cent. Of the tonnage building 3,643,802 tons were for export, of which Japan was building 23·7 per cent, West Germany 20·3 per cent, Sweden 13·7 per cent, and Great Britain and Northern Ireland 7·1 per cent. Throughout the world 5,234,214 tons representing 54·6 per cent of the ships under construction were classed with Lloyd's Register.

Electron Beam Parametric Amplifiers

Two forms of parametric amplifier for microwave circuits were described and demonstrated in a lecture on "Beam-Type Parametric Amplifiers: Some Aspects of their Design and Use," given to the Electronics and Communications section of the Institution of Electrical Engineers on January 29 by R. B. Dyott and C. R. Russell. A parametric amplifier was defined as some sort of resonant system with one element which could be varied periodically. One of its main advantages was the very low noise figure obtainable without going to the trouble of refrigeration, as was necessary with a maser. A simple mechanical analogy was demonstrated in the form of a pendulum, by showing how shortening the length of the pendulum in the correct phase and at twice the frequency of the system increased the amplitude of vibration. An electronic equivalent was a parallel resonant circuit, with a variable-capacitance diode or ferrite inductance. Varying either of these elements had the effect of transferring energy to the circuit so that amplification was produced.

The parametric amplifiers described in the lecture both depended on the modulation of electron beams. In the Adler tube the beam was acted on by a transverse magnetic field, which was varied in such a way that the beam electrons were caused to rotate at the cyclotron frequency, and this rotational energy could be taken off by an output coupler. Noise generated in the beam by the cathode of the electron gun would have a rotational component, which also could be removed by coupling to an external circuit loaded with the appropriate resistance. So far no gain had been introduced, and in this form the tube could be used as an isolator. In order to provide gain, the rotational energy in the beam had to be increased between the input and output couplers at opposite ends of the tube. Some variable parameter associated with the resonant frequency of the system must be found, and it was to hand in the longitudinal magnetic field in the tube. The circular motion of the beam electrons could be regarded as two simple motions at 90 deg. to each other, against which the magnetic field exerted a restoring force. Variation of this field at twice the system frequency would provide the desired energy transfer. Four plates were therefore located round the beam in the centre of the tube and to these a frequency of twice the cyclotron frequency was applied. These plates provided an electric field which modified the magnetic field, resulting in an increase of rotational energy in the beam, so that the tube now had gain. The first Adler tube, operating at 200 Mc/s, had a gain of 20 dB and noise of 1·3 dB.

The second electron beam parametric amplifier described made use of the fast and slow space charge waves produced when r.f. was applied to an electron beam. It was stated that the characteristics of this amplifier were still under investigation to determine its practicability. The fact that there were more electrons travelling slower in the slow space charge wave meant that this wave was increasing in amplitude. In the fast wave the beam energy was increasing, and the noise in this wave could be extracted by means of a coupler before the signal was applied. Assuming a 2500 Mc/s signal, the pump frequency would be 5000 Mc/s, and amplification resulted from interaction between the field set up by this frequency and that of the fast space charge wave. The principal asset of the space charge wave amplifier was its bandwidth. This gave it possibilities as a low-noise amplifier for television, particularly in view of the fact that travelling wave tube amplifiers for the v.h.f. band would be inconveniently long.

Synthetic Aggregate for Aluminous-Cement-Concrete

A SYNTHETIC aggregate for use with "ciment fondu" high alumina cement, the resultant concrete attaining appreciable density, hardness and strength in twenty-four hours and also being heat-resistant, is announced by the Lafarge Aluminous Cement Company, Ltd. The new product is called "Alag" and is dense, non-absorbent and extremely hard, with a hardness of 7 to 7·5 on Moh's scale. Concrete made from it is able to withstand temperatures up to 1200 deg. Cent., it is claimed. It should not be used with any type of Portland or super-sulphated cement.

After twenty-four hours the compressive strength of the "Alag" concrete is given by the makers as 13,000 lb per square inch, compared with 7500 lb per square inch for normal ciment fondu concrete. The seven days strength is stated to be 16,000 lb per square inch. The makers further assert that tests have demonstrated that superior strength is approximately maintained through a heat range of 600 deg. to 1200 deg. Cent., figures for the higher temperature being 3800 lb per square inch, compared with 2800 lb per square inch for ordinary refractory concrete. The density of ciment-fondu "Alag" concrete is approximately 170 lb per cubic foot air-dried, which is about 20 lb per cubic foot greater than for concrete made with ordinary structural aggregates, and about 40 lb per cubic foot greater than refractory concrete made with an aggregate of crushed firebrick, which has similar expansion characteristics. "Alag" is supplied in two sizes: coarse, $\frac{1}{4}$in to $\frac{1}{16}$in, and fines, $\frac{1}{16}$in to dust.

[Reply Card No. E2343]

Slade Green Collision Report

THE Ministry of Transport report has been published on the collision which occurred on February 17, 1959, on the Slade Green–Dartford section of the Southern Region, British Railways. In foggy conditions, the 9.25 a.m. Charing Cross to Dartford electric train, while standing at Crayford Spur "A" home signal, was run into in the rear by the 9.40 a.m. Charing Cross to Gillingham electric train, travelling at about 15 m.p.h., which had been wrongly admitted to the block section. There were seventeen casualties, none of them serious. The inspecting officer finds that the signalmen at Crayford Creek Junction and Crayford Spur "A" boxes were both responsible for the accident. He is satisfied that the former did not give "train entering section" for the 9.25 a.m. train, and was not given a "train out of section" message for it which he had recorded as being received at 10.50 a.m. In order to release his starting signal for the 9.40 a.m. train, he failed to carry out the proper procedure in requesting a second "plunge" on the Sykes lock and block instrument from Crayford Spur "A," and the signalman there failed to make sure which train was in question when asked on the telephone to release the lock on his instrument and give the second plunge. He assumed that the release was required for the 9.25 a.m. train, although this train was already standing at his home signal. The inspecting officer remarks that uncertainty can arise over interpretation of the two-position block indicator as installed at these boxes. This can be overcome by an improved indicator with three positions, and he reports that the railway authorities are examining the addition of three-position indicators to the Sykes lock-and-block at boxes in the area of this accident, as a temporary measure which will be an exception to the general policy of fitting standard three-position instruments with full electrical controls.

Heads of the Valleys Road

WORK is to start on the reconstruction of the Heads of the Valleys Road in Wales. The existing A.465 road between Abergavenny and Hirwaun, which passes through mountainous country and rises to a height of nearly 1300ft, will be transformed into a new highway for a total distance of about 24 miles. At the eastern end, the Heads of the Valleys Road will be linked to the Ross Spur Motorway, now under construction, by the modernisation of the existing road between Abergavenny and Ross. The Minister of Transport has awarded the contract for the construction of the first 7-mile section of the new trunk road—between Abergavenny and Brynmawr—to John Morgan (Builders), Ltd., of Cardiff, whose tender was £1,333,912.

The new road, with a 33ft carriageway, will leave the A.40 just south of Abergavenny and run in a north-westerly curve through the valley of the Usk to Gilwern. A new bridge, with a centre span of 140ft, and two side spans each of 40ft will carry the road over the river Usk.

The main feature of the bridge—which promises to be an excellent and graceful example of modern design—will be two groups of six V-shaped supports carrying slender beams of post-tensioned prestressed concrete.

The scheme has been prepared by Messrs. Rendel, Palmer and Tritton, the consulting engineers for the whole Heads of the Valleys Road project, who will also supervise the construction. Plans for reconstructing the 17 miles from Hirwaun to Brynmawr are in course of preparation.

Instruments Exhibition in Moscow

AN exhibition of British scientific instruments will be held in Moscow from June 16 to 26. It has been arranged as an outcome of a report presented to the council of the Scientific Instrument Manufacturers' Association of Great Britain by a three-man delegation which went to Moscow in November, and is supported by thirty members of S.I.M.A. This exhibition, it is stated, will be the first to be put on in Russia by a British organisation of manufacturers in a specialised field.

Amphibious Sidecar

A TRUE launch sidecar has been designed and put into production by Canterbury Sidecars, Ltd., Arisdale Avenue, South Ockendon, Romford, Essex. The sidecar boat, the "Canterbury Belle," is a two-adult craft of classical construction in ash frames and resin bonded ply, joints being made with both screws and marine glue; it is expected that production will be about seventy per week. The hull form is V-bottom and hard chine, with a rubbing strip immediately below the chine. Stabilising fins project beyond each quarter, and are submerged when the passenger seat is occupied. In the water, propulsion is by a 4in propeller running up to 3000 r.p.m. and having a pitch angle of 8½ deg. to 10 deg. The screw is shielded by the bracket of the long, unbalanced rudder; steering is by a tiller moving in the pitching plane and having a response natural to the left hand, i.e. pull-port and push-starboard. The size of screw and rudder is, of course, severely restricted by the need for ground clearance when moving on wheels. The engine, a J.A.P. "J.S.8" of 79·7 c.c., is coupled to the propeller without clutch or gearing and will develop about 1½ h.p. at 7 knots. Having a recoil starter, the engine can afford forward propulsion only; the controls are limited to a lever throttle on the pilot's right, petrol tap, strangler, and a spring steel strip on the cylinder head that earths the sparking plug terminal (the ignition is not waterproofed). The exhaust is not water-cooled, a small silencer being mounted in the open behind the counter. The particulars of the boat proper are: length 7ft 7½in, width 3ft 2in over stabilisers, beam 2ft 8in, depth (keel to gunwale) 1ft 7in, weight 155 lb approximately.

Two-seater sidecar boat; a single-cylinder air-cooled two-stroke engine is installed below the shielded intake on the fore deck

The sidecar is carried on land by a GMC/10B chassis weighing 98 lb and having a track of 4ft 4in. This chassis is a slightly modified version of a standard sprung, braked outfit, having a trailing arm pivoted on a Silentbloc bush and controlled by an Armstrong telescopic spring and damper unit; as usual, a high suspension frequency is used because of the direct effect of roll upon the steering. The hull is supported by two shallow "Vees," the front one rubber padded and the rear one having a pair of slots, rising toward and open at the rear, which engage legs projecting sideways immediately above the chine. A rubber pad prevents the hull fretting against the spring abutment. The four point mounting is adjusted by loosening clamps on the large tubes. For obvious reasons, the body has no doors. The outfit is illustrated coupled to an Ariel "Hunter" Twin.

[Reply Card No. E2351]

Tank Contents Gauge

A HYDROSTATIC tank contents gauge introduced by Firth Cleveland Instruments, Ltd., Stornoway House, Cleveland Row, London, S.W.1, is designed to measure the liquid contents in most forms and all sizes of non-pressurised tanks. It consists of an indicating and a transmitting instrument coupled together by an airline which can be up to 250ft long. The indicator is available with dials from 4in to 12in diameter and graduated to show either the depth of liquid or the tank contents in gallons or units of weight. It gives a continuous check of the amount of liquid in the tank.

The transmitting instrument, which weighs 12 lb, can be mounted in or on the tank in various ways to meet particular requirements. It can be fixed on the outside of a tank, and connected by a short pipeline to just above the sludge level of the contents, or mounted or suspended within the tank above sludge level. When the transmitter is installed in a tank the liquid fills a lower chamber and presses up against the lower surface of a synthetic rubber diaphragm. From the upper chamber of the transmitter this pressure, the hydrostatic head of liquid in the tank, is transmitted through a small bore copper or nylon airline to the indicator where it actuates another diaphragm coupled to the dial needle.

The diaphragm in the transmitter has a graduated thickness so that in operation it is similar to a rigid piston of large area sealed to the chamber walls by a flexible membrane around its edge. Its design is such that errors due to changes in atmospheric pressure or in the temperature of the air in the sealed pipe system are reduced to negligible proportions. It is stated that the maximum 250ft length of airline should only be used if the greater part of its length is exposed to atmospheric temperature, and the maximum recommended working temperature is 150 deg. Fah.

When installing this equipment it is necessary to know the density of the fluid in order to calibrate the indicator in depth units, and also the tank size and shape of readings are required in volume or mass units. These gauges are suitable for use with all liquids compatible with the transmitter, which is normally made of cast iron. If required the equipment can be arranged to give alarm indication of high and low tank levels and for the automatic control of a pumping installation to maintain liquid levels between predetermined limits.

[Reply Card No. E2352]

Office Electronic Computer

AN addition to the number of small computers for office installation has become available by the introduction of the Royal McBee LGP-30 model illustrated, a product of the Royal McBee Corporation of the U.S.A. Sales in this country are being handled by the Visible Writing Machine Company, Ltd., 36, Worship Street, London, E.C.2. At a recent demonstration it was stated that the computer has been designed primarily for engineering applications, and it was shown working on a highway design problem. The computer is mounted on castors and, exclusive of typewriter and desk, measures 2ft 7in deep, 3ft high and 3ft 10in long. The weight is 800 lb. Input and output speed with the electric typewriter is ten characters per second, but an ancillary high-speed photo-electric reader (210 characters per second) and high-speed paper tape punch output (twenty-five characters per second) are available. The operating code consists of sixteen single-letter instructions which are converted into binary symbols in the computer.

The computer operates on the drum storage principle and has a 3600 r.p.m. drum with sixty-four tracks of information. Registers are written completely round the drum and there are no delay lines. Memory capacity is 4096 words with a length of thirty-two bits including sign and space bit. The present model uses 110 miniature valves, with printed circuitry and time-sharing of components. Average maintenance time required was stated to be two hours per fortnight.

General-purpose desk-size digital computer and electric typewriter

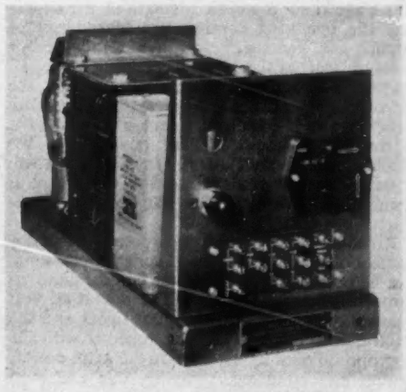
The LGP-30 is the first of a line of computers for engineering calculations, and a more powerful and faster instrument, the RPC-4000, has just been announced in the United States for delivery in the summer of this year. This will be fully transistorised and will have the capacity for handling seventeen output/input devices at one time, or sixty-four devices by the addition of one transistor circuit. It will be nine or ten times as fast as the LGP-30 normally, or sixty times as fast in some modes of operation.

[Reply Card No. E2353]

Chokeless Power Supply Sub-Units

ADDING to its range of stabilised power supply sub-units, the Solartron Electronic Group, Ltd., Thames Ditton, Surrey, has introduced a new series in which smoothing chokes are dispensed with. The usual capacitors are incorporated, and ripple remaining in the output is fed back through an amplifier which applies a bias to the grid of a valve in series with the output circuit in the sense required for smoothing. The units are designed for pulsed loading conditions and can withstand pulsing from zero to full load without self-oscillation or loss of control. It is stated that the units maintain a stability factor of better than 400 to 1, while a low source impedance of 0·5 ohm is held up to a frequency of 0·5 Mc/s. The range comprises three sub-units of 100mA maximum load capacity and three of 200mA, output voltages covering from 100V to 400V. The output voltage of any sub-unit can be varied over ±50V from nominal. Reactive loads may be applied without affecting the specified performance.

[Reply Card No. E2354]

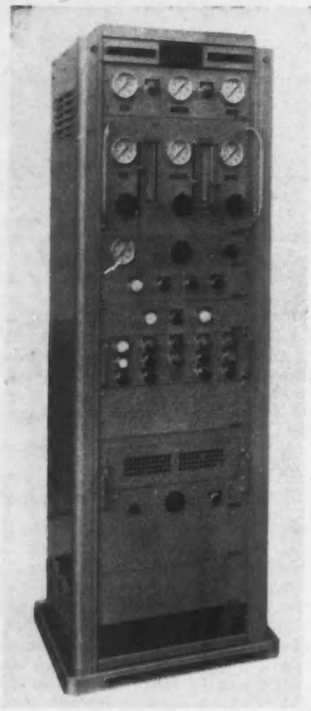


Power supply sub-unit with feedback smoothing circuit

SHORTER REPORTS *(Continued)*

Automatic Control Equipment for Metal Spraying Plant

AN automatic electronic control equipment for heavy-duty or production metal spraying installations now available from the Metallizing Equipment Company, Ltd., Chobham, Woking, Surrey, will operate with both wire and powder metallising processes. For wire spraying the control unit is used in conjunction with the firm's "Metco" Type K gun and, for hard-facing applications, using tungsten carbide,



Automatic control equipment for metal spraying plant

Ni-Cr alloys and ceramics, with the "Thermo-Spray" gun.

The basic equipment incorporated in the cabinet to be seen in our illustration includes electrically controlled on-off, inlet air, oxygen and gas valves. Permanent connection is made to these valves from the main factory supply lines and gauges are fitted to show the supply pressures. As soon as fuel gas is supplied to the control system a ventilating fan at the bottom of the cabinet is started and indication is given by a green light at the top of the panel. If at this stage there is no air pressure in the supply line the operating controls are locked out of circuit and remain inoperative until the air pressure reaches the normal operating level. If, during operation of the spraying machine, the air supply should fail for any reason, the entire machine will automatically shut off. Similarly, if the flame should fail for any reason, the machine will be shut down. In all cases where a safety control shuts down the equipment it requires positive action by the operator to re-start the system.

Remote control can be incorporated whereby control of two or more metal spraying machines can be operated from a master control panel or some other remote point. The operating unit consists of control buttons, pilot lights and the electric circuits. The buttons, together with the appropriate pilot lights, operate the main power, testing and adjusting, spraying, idle and stop circuits. With the controls set, depression of the metallising button starts the lighting and operating sequence. A time relay first opens the air, oxygen and gas valves to purge the lines, and then partly closes the valves to allow sufficient gas and oxygen for lighting purposes and operates the automatic igniter. In the next step of the starting sequence the relay opens the valves fully and finally starts the wire feeding.

While spraying is in progress the speed of the wire feed is maintained precisely by the electronic controls which cover a range of speeds adequate for all normal metal spraying operations. When the appropriate button is pressed to initiate the idle condition wire feeding stops and the gas and oxygen flow are reduced to leave only a pilot flame alight on the spraying gun. Depressing the start button then returns the flame to normal and starts the wire feeding again. If required this idling control sequence can be automatically operated by the component when spraying work on a production basis.

When the system is shut down at the end of a run all gases and pressures may be drained by operating the controls normally used for initial adjustments. Normally the control cabinet is permanently fixed in the most suitable operating condition, but it can be fitted into a castor mounted base to permit ready movement of the whole unit. The automatic control system equipment is so designed that units can be readily added to the basic assembly to meet special requirements for any particular operation.

[Reply Card No. E2361]

U.H.F. Telemetry Equipment

IT is a common occurrence in engineering that it is required to monitor the behaviour of a vehicle, manned or unmanned, and in many cases the equipment for rendering visible or permanent the records is too bulky to go aboard. In development work too it is often desirable to have several vehicles fitted with transducers but to use only one set of recording gear. The answer in this case is to telemeter the transducer outputs back to a base, and a complete equipment for this purpose is now offered by Sir W. G. Armstrong Whitworth Aircraft, Ltd. It works in the u.h.f. (line of sight) band, being intended primarily to communicate with missiles of rather short range, but it is pointed out that road vehicles, for instance, are commonly tested on a known track and hence remain close to a fixed point. The equipment provides twenty-four channels by time division multiplex and, as an optional extra, two simplex telephone channels. The input required is of the order of 5mV into a 1kΩ impedance, and the output ±15V into 30kΩ. The information is impressed on a sub-carrier by frequency modulation between 120–160 kc/s, the synchronising pulses being 180 kc/s; the frequency of the intelligence is limited by the sampling rate of sixty per second set by the mechanical switch (an electronic switch to exploit the full available bandwidth is under development) but this limitation can be pushed back by allotting more than one channel to a given input. The radio frequency can be varied without any delay in changing crystals or tuning.

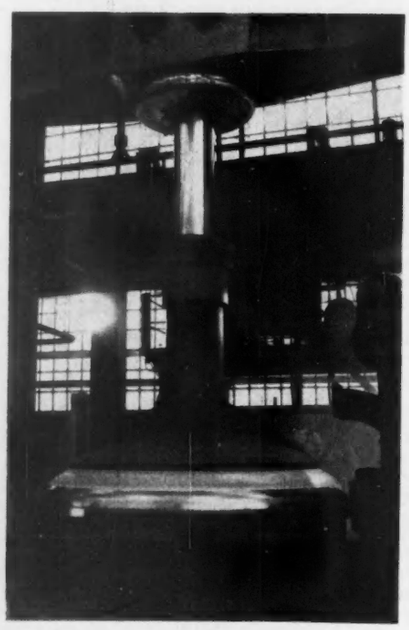
The transmitter of the u.h.f. telemetry link is seen here inside a car; it runs off the battery and consumes about 60W

It is pointed out that, even in a manned vehicle, telemetry can allow far more instruments to be monitored than the crew alone could cover—this is, of course, exploited in the case of the X-15 hypersonic single-seater—and we are advised that A.W.A. equipment may be installed in Mr. Donald Campbell's land speed record contender for this purpose.

[Reply Card No. E2362]

Large Spun Aluminium Pressure Vessel Ends

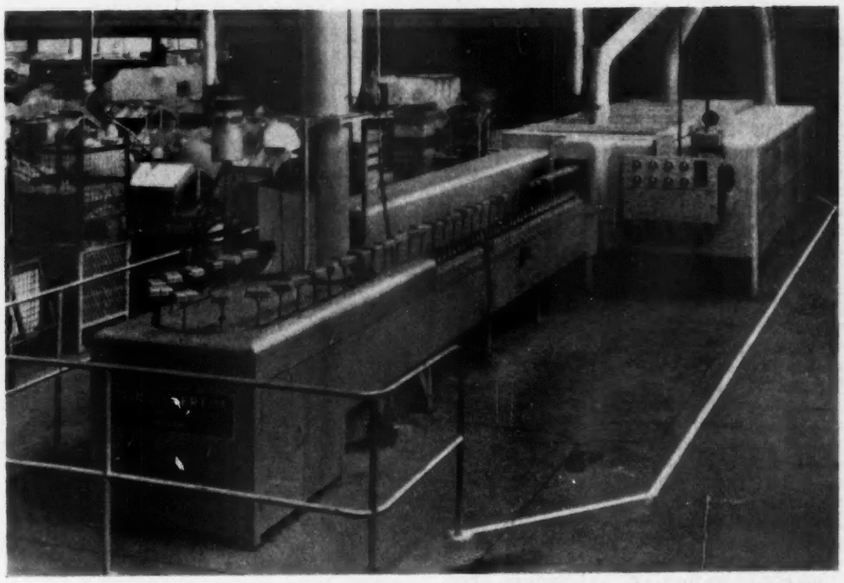
WHAT are believed to be the largest aluminium spun ends yet produced in this country have been made at the Greenwich works of G. A. Harvey and Co. (London), Ltd., for some liquid air pressure vessels. These ends, when completed, had an inside diameter of 10ft and their wall thickness was 1¾in. To provide each of the flat discs from which the ends were spun, two aluminium alloy plates were butt welded together.



Spinning a 10ft diameter aluminium-alloy pressure vessel end

Our illustration shows one of the aluminium alloy ends being spun on the large machine at the Harvey works. This machine is normally used for spinning the "Rotarprest" ends of heavy steel pressure vessels. It is capable of working with steel plates weighing up to 10½ tons, producing dished ends 15ft diameter and above, and handling plate thicknesses of up to 4½in.

[Reply Card No. E2363]



Continuous radiant stoving plant working in conjunction with an automatic paint spraying equipment

Continuous Stoving Installation

AN electric radiant stoving installation has been supplied by G. and R. Gilbert, Ltd., Hackbridge, Surrey, to an electrical switchgear manufacturer for working in conjunction with an automatic spraying machine used to paint switch and starter cases and lids. Depending upon the size of the workpieces handled, the installation has a designed throughput of from 960 to 1920 pieces per hour.

The parts to be painted are loaded by hand at the right-hand side of the plant seen in the photograph we reproduce. The parts are supported on vertical spindles projecting up from carrier skates on an endless roller conveyor chain which extends right round the plant. The links of the chain are protected in the painting and drying zones by a slotted cover through which the spindles project. After the parts loaded on the spindles pass round the end of the plant in the foreground of the illustration they enter the automatic spray painting enclosure. From this enclosure the painted parts are carried directly into a tunnel where the excess solvents are flashed-off.

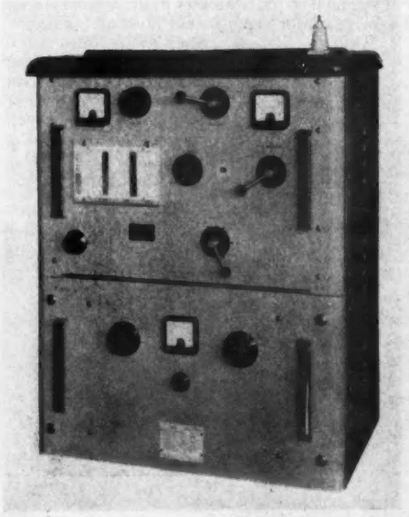
The exit of the flash-off tunnel adjoins the entrance to the stoving oven chamber, which is heated along some two-thirds of the length of conveyor line enclosed in the oven structure. The stoving section is well insulated to reduce thermal losses and heating is effected by electric radiant emitters set along the top of the tunnel, with auxiliary reflectors arranged below the line of workpieces to impart uniform overall stoving of deep pressed sections. This stoving section is designed to operate on a full heat load of only 27kW. Beyond the stoving tunnel the parts pass through a forced draught cooling tunnel where they are cooled sufficiently to allow handling at the subsequent unloading station.

[Reply Card No. E2371]

Marine Radio Transmitters

Two ships' 600W radio transmitters of similar construction and overall dimensions, but for long-range h.f. and local coastal station communication respectively, are now in production by A.E.I. (Woolwich), Ltd., Woolwich, London, S.E.18. We illustrate the T50H h.f. transmitter for w/t and r/t in the 4-22 Mc/s bands. This comprises a T54 transmitter and M56H modulator in a table-mounting rack, forming an assembly measuring 3ft 6in high (including aerial insulator), 2ft 5in wide and 1ft 9in deep. Power supplies are taken from a separate floor mounting unit. Thirty spot frequencies are available for w/t, five in each band, with the use of eleven crystals. The form of telegraphy transmission is c.w. without audio modulation, as required by the Post Office instructions for long-distance ship-shore radio communications under the area scheme. Radio telephony is amplitude-modulated, and five spot frequencies may be used in the five r/t bands between 4 Mc/s and 22 Mc/s. Facilities are provided for simplex, voice-operated or duplex working. Speech inversion can be fitted if desired.

Referring to the illustration, the transmitter is the upper unit, and the controls for band and channel selection are seen at the bottom of the panel. The power amplifier tuner is at the top left, adjacent to a P.A. cathode current meter, and to its right are the aerial coupling control and aerial ammeter. Aerial tuning is effected by the coarse and fine controls in the centre of the panel. Principal controls on the modulator



Ship's radio transmitter for long-range h.f. communications

are for service selection and power adjustment, the latter permitting power to be reduced in four steps to less than 20W. Maximum carrier power of the transmitter is 600W to the aerial circuit, which will give 200W/450W with a normal ship's aerial according to the frequency band in use.

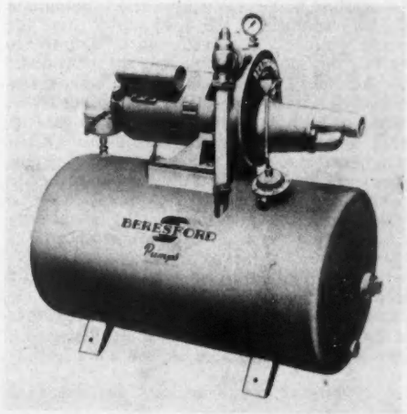
The second transmitter, T50M, is of similar construction and dimensions but provides c.w. or m.c.w. telegraphy (with a 650 c/s tone) in the 405–525 kc/s band (eight spot frequencies) and 1·6–3·8 Mc/s band (eleven spot frequencies) together with amplitude-modulated telephony in the latter band. Aerial power on normal ships' aerials on m/f is 350W and may be reduced in four steps to less than 5W. On the intermediate band (1·6–3·8 Mc/s) the power in the aerial is 100W, and may be reduced in two steps to under 10W. Volume compression is provided on all r/t transmissions, and the transmitter can be equipped for speech inversion. An aerial switch containing a dummy load for transmitter testing is normally fitted. In both equipments access to the transmitter components is gained through the front panel, which is hinged at its lower edge. The modulator is fitted with ball-bearing slide runners which enable it to be withdrawn for servicing.

[Reply Card No. E2372]

Pressure Water Supply Equipment

AN automatic pressure water supply equipment has been developed by James Beresford and Son, Ltd., Kitts Green, Birmingham, 33, for installation in country houses, farms, &c., dependent upon wells or boreholes for their water supply. It can be installed near the head of the well or in the house, and eliminates the use of a roof tank unless a feed is required to a boiler or central heating system.

The new equipment, to be seen in our illustration, comprises a motor-driven centrifugal pump



Automatic equipment providing a pumped pressure water supply from a well or borehole

mounted on a pressure water storage tank together with a regulating device which includes an air volume control and pressure switch. The tank contains a cushion of air which is automatically maintained by the air volume control operating in conjunction with the pump. As water is drawn off the air pressure and the water level in the tank drop until at a predetermined point the pressure switch automatically comes into effect to start the motor. When the water in the tank is replenished the switch operates to cut out the pump motor. A reasonable amount of water can be drawn from the supply system before the motor is cut in so that the motor only operates infrequently under normal domestic conditions.

Two models of this equipment are available, each capable of a maximum vertical suction lift of 20ft. The smaller model, driven by a ¼ h.p. motor, gives discharge pressures from 15 lb to 35 lb per square inch and has a capacity up to 390 gallons an hour when used with a shallow well. It has a storage tank with a capacity of 18 gallons, and can be adapted for deep wells requiring a lift of 45ft with only a slight reduction on the maximum operating pressure and output. The larger model is driven by a ½ h.p. motor and is fitted with a 32-gallon storage tank. It has a discharge pressure of 20-24 lb per square inch and an output of up to 610 gallons per hour. This large equipment can also be adapted for use with deep wells where suction lift of 80ft is possible.

[Reply Card No. E2373]

SHORTER REPORTS *(Continued)*

Controlled Creep Speed Drive for Cranes

IN developing the "Electrocyclic" system for creep speed control of overhead electric travelling cranes, the Reed Crane and Hoist Company, Ltd., Lodge Causeway, Fishponds, Bristol, has followed the principle of meeting the fundamental requirements of such a drive with standard forms of motors and electrical control gear. An auxiliary motor for providing the creep drive is direct-coupled to a single-ratio (usually 10 : 1) epicyclic reduction gearbox, the output shaft of which is in turn directly coupled to the main drive motor. The gearbox is controlled by an electromagnetic brake which, when applied, locks the planetary carrier so that torque from the auxiliary motor is transmitted through the reduction gear, and when released allows the motor to run free without transmitting torque. Thus, the auxiliary motor rotates continuously while the crane is in operation and is therefore available to take up the drive virtually instantaneously without stopping and without shock such as might be experienced with a clutch system for engaging the creep speed.

The electrical connections are arranged so that when the main motor starting contactor closes, the gearbox brake is energised and released and auxiliary contacts in the main starter cause the auxiliary motor contactor to close, simultaneously starting this motor and releasing the main brake of the crane. In these conditions the crane hoists or lowers at its fast speed, the drum being driven by the main motor through the normal gearing, while the auxiliary motor runs light. When creep speed is selected, the main motor contactor opens and this motor and the gearbox brake are de-energised simultaneously. Application of the brake locks the planetary carrier as already described and the auxiliary motor at once takes up the drive via the reduction gear, the main motor shaft and the crane gears. To restore full speed, the main motor is again energised and the procedure is reversed. The main holding brake of the crane is energised from the auxiliary motor terminals and is therefore applied automatically by the opening of the auxiliary motor contactor if the crane is stopped while running at creep speed. For a stop at fast speed, when both motors are energised (although only the main motor is driving), the two motor starting contactors are tripped simultaneously so that the holding brake is again applied without further switching operations. A supply failure applies the brakes automatically in either condition.

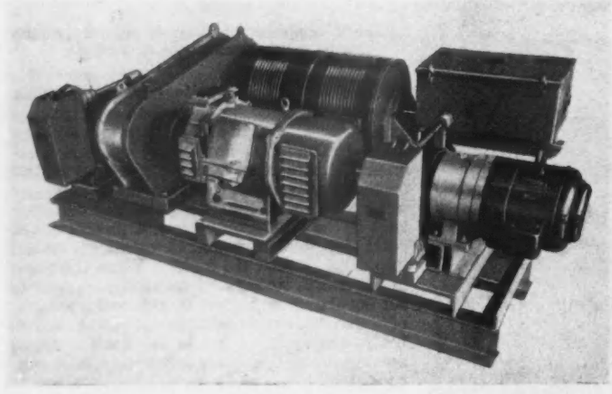
The inherent characteristic of the three-phase auxiliary induction motor used in this creep speed drive provides automatic dynamic braking while lowering. Reversal of the drive is also accomplished smoothly and without shock, the motors simply braking to a standstill and then starting to run in the opposite direction. The only variations in creep speed are those due to the normal slip characteristics of the cage motor, and the maker guarantees maintenance of the creep speed within plus or minus 1½ per cent of full speed irrespective of the load on the hook and/or direction of motion.

The operation of the drive was demonstrated to us recently, when the characteristics already mentioned, and also the simplicity of control, were apparent. On this occasion the drive was controlled from a pendant type of push-button controller selecting fast or creep speed in either direction. Lengthy study and analysis of the requirements of crane users have accompanied the development of the drive, and it is considered that in general two speeds meet all operating needs, while there is growing demand for floor control of cranes by operators without special training, but with no relaxation of the need for accurate and positive creep control. It is felt, therefore, that the drive with floor push-button control is particularly applicable to present requirements in foundries and machine shops. The system can be applied equally readily, however, to cranes with drum controllers, when the creep drive is brought into action on the first notch. In the drive we inspected, the electrical control gear was housed in a cubicle and was seen to consist throughout of conventional types of motor contactors and overload relays. Similarly, the gearbox represents the application of a well-proved device, the work of development having been directed to adapting it to the particular stresses and conditions of crane operation and not to a modification of accepted principles.

The "Electrocyclic" drive is stated to be applicable to any existing type of overhead electric crane, details of mounting the motors and gearbox being variable to suit conditions. It may be used in conjunction with a squirrel-cage or slipring main motor, and there would be no obstacle to supplying it with more than one creep speed ratio, or with a variable speed auxiliary motor, were such requirements to arise. An example of the flexibility of the system is that the drive can be arranged for hoisting (or travelling) to a dead stop, the torque transmitted through the gearbox being preset to a limit at which the load will simply be held fully by the auxiliary motor. This may result in a sustained overload and the overload relays are accordingly set to operate after a short delay, thus switching off the auxiliary motor and applying the main crane brake. Such an arrangement has been adopted where otherwise frequent operation of limit switches would be likely to occur, requiring correspondingly frequent inspection and maintenance. With this adjustment of the drive, the limit switches serve as a second line of defence and are not subject to continuous wear. In another instance, the drive has been supplied with automatic cycle features for operating a skip winch. The accuracy of control would also enable the system to be used effectively for such specialised operations as the handling of nuclear fuel elements at atomic power stations, and equipment is offered for cranes which place the elements in the storage ponds and reclaim them from precisely-indicated positions under water.

We are informed that a working model of the "Electrocyclic" drive is available for demonstration anywhere in the country.

[Reply Card No. E2381]



Crane speed drive applied to a winch. The epicyclic gearbox is seen between the auxiliary motor (right) and main motor (left)

Low Capacity Powder Pump

A PUMP which is stated to be suitable for the conveyance of practically any type of powdered material which can be fluidised by air, has been introduced by Henry Simon, Ltd., Stockport. This pump, depending upon the class of material, can handle up to 8000 lb of powder an hour, and with it vertical lifts up to 70ft are being effected with total conveying lengths of 200ft.

A diagram we reproduce shows the basic design of one of these "Squeegee" pumps,

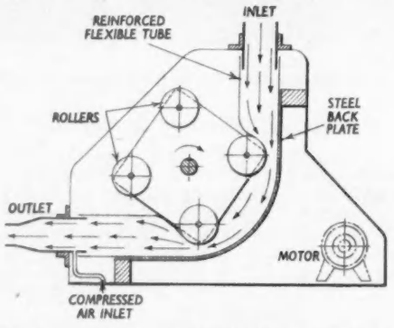
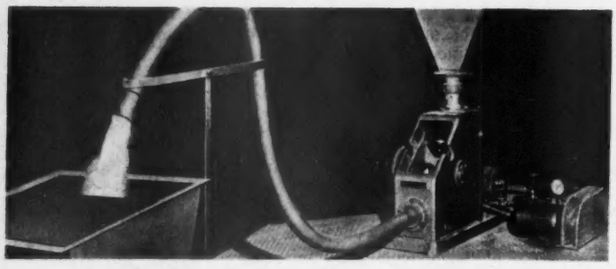


Diagram showing the construction of a powder pump

as they are called. The pump incorporates an open-ended flexible tube, a rotor carrying four equally-spaced rollers and a compressed air inlet. As it turns the rotor progressively squeezes the powder through the bend in the flexible tube supported against a steel backing plate; the rollers serving to thrust the material through the tube in a continuous stream. At the exit section of the tube a supply of compressed air is delivered into the material and this air is prevented from leaking back through the pump because of the pressure maintained by the rollers. The compressed air is used solely for conveying the powder through the delivery line and, it is stated, under normal conditions about 15 to 20 cubic feet a minute is adequate to give the required output.



Demonstration set-up of a powder pump

Should the supply of powder be exhausted, a pump can continue running without sustaining any damage and its flexible tube is quickly replaceable when worn out. Again depending upon the class of powder handled, a flexible tube life of up to 1000 hours can be expected. These pumps are made in two sizes with 2in and 3in diameter flexible tubes and they are driven by a 1 h.p. motor. The stock is discharged with but little turbulence owing to the small quantity of air used and no elaborate dust collection equipment is needed with a pumping set.

[Reply Card No. E2382]

INDUSTRIAL NEWS

Shipbuilding Wages and Hours

The claims for a substantial wage increase and a forty-hour week in British shipbuilding and ship repairing yards were further discussed on Thursday of last week when the Shipbuilding Employers' Federation met representatives of the Confederation of Shipbuilding and Engineering Unions. The claims were rejected by the employers on November 18 last.

At last week's meeting, the president of the Shipbuilding Employers' Federation, Mr. G. H. R. Towers, emphasised that there had been no real change in the shipbuilding industry. The very few orders which had been taken, he said, had all been secured in the face of the keenest competition, and at very low and unremunerative fixed prices, in the interests of shipyard production programmes and of maintaining employment. The repair work position, Mr. Towers added, was very much the same so that prospects generally were not, unfortunately, any brighter. At the meeting in November, Mr. Towers recalled, he had made it perfectly clear that in view of the unfavourable outlook for both shipbuilding and ship repairing all their efforts must be directed towards reducing prices and the employers could not, therefore, agree to increased wages.

So far as working hours were concerned, Mr. Towers said the employers had already stated that they were not opposed in principle to a reduction. It was absolutely essential, however, before any such claim was considered, that the obstacles to maximum efficiency should be removed. In fact, at the previous meeting, the employers said that if the unions were prepared to co-operate with them they might still be able to do something to meet the claim for a shorter working week. But it would be dishonest to suggest that, without that co-operation, the industry could face up to a reduction in hours at the present time when the position was so grave. Mr. Towers went on to say he felt the union representatives would all appreciate how important it was that shipbuilders and ship repairers should be able to tender for work knowing that they could carry through that work without interruption.

Buying Capital Equipment

The British Association of Machine Tool Merchants has submitted some Budget suggestions to the Chancellor of the Exchequer. The Association urges that every possible incentive and encouragement should be given to industry to expand its productive capacity by installing a full range of machinery and plant ; it hopes accordingly that the fullest consideration will be given to that in the formulation of the Budget.

The Association goes on to remind the Chancellor that machine tools are the " master tools " of industry and are, in fact, an essential requisite of all forms of industry, either in themselves or as the producers of other machinery. The Association feels that the present method allowing plant and machinery to be written off at fixed percentage rates over a long period of years is a deterrent to expansion programmes. The suggestion is made, therefore, that it should be left to the taxpayer to determine the period over which the machine tool requires to be depreciated and replaced and that no restriction should be placed on the manner in which this takes place. The Association's council is also concerned that the investment allowance is still not granted to purchasers of competently overhauled and rebuilt used machine tools, the more so now that delivery dates for new machines are again being extended, with a resultant increasing demand for used machines, especially by the less well financed and smaller firms which represent about 85 per cent of users.

Transport's " Changing Scene "

An address entitled " The Changing Scene in Transport since 1947 " was delivered before the Metropolitan Section of the Institute of Transport, last Monday, by Sir John Benstead, deputy chairman of the British Transport Commission. In the main, Sir John commented upon various aspects of the Commission's functions and responsibilities since it was set up in 1947.

In the latter part of the address, Sir John spoke in particular of the impact on the Commission's staff during what he called " these years of change and stress." Nationalisation, he said, had been the subject of so much political controversy that sometimes any stick had been good enough to beat those employed in a publicly-owned corporation. Unlike most of industry, public transport was open to the public eye ; its shortcomings were visible, which made it an open target. As to the future, speaking especially of the railways, Sir John said that public ownership was not in dispute and should not, from any ideological view, be a source of political controversy. What was required was a public understanding of the problem of transforming a nineteenth century system to one capable of meeting the needs of this century. The electrification of the London Midland system alone, he commented, was one of the greatest industrial tasks of the day, especially as the work must be carried out under full operating conditions. The British Transport Commission, he added, was trying to compass in a few years the work of many, but he was satisfied that there would be regained this country's former leading position among the railways of the world. What was needed, he remarked, was not sympathy but understanding.

Industrial Training

The first report of the Industrial Training Council has just been published. The council, it will be recalled, was formed in July, 1958, under the chairmanship of Lord McCorquodale and includes representatives of the British Employers Confederation, the Trades Union Congress, the nationalised industries, the Ministry of Labour, the Ministry of Education, and educational bodies. As the report points out, the council's task is not to train young people. It is to act through employers' organisations and bodies composed jointly of employers and trade unionists to stimulate individual companies to improve their training schemes and, in the first place, to prepare for the school leavers' " bulge " in 1961, 1962 and 1963. The report records the progress which is being made by sixty employers' organisations and joint bodies. The activities described include the assessment of future requirements, the appointment of training development officers, the development of improved training procedures, arrangements to strengthen the links between industry and local education authorities and technical colleges, the issue of recruitment and training literature, and the reconsideration of existing training schemes and training methods. These, the report says, are essential preliminary steps. But, it adds, more needs to be done and more industries can with advantage to themselves follow the lead that has been given.

In a statement on the expansion of industrial training, the British Employers' Confederation says it is reasonably clear that jobs will be available for new entrants to industry in the " bulge " years 1961–63 ; there will be no real difficulty, the Confederation believes, in securing that they are trained. The crucial factor, the statement comments, is the state of the economy ; if the country moves into a further period of sound expansion, the problems of employment and training will largely solve themselves. There are, the Confederation adds, already signs of expansion in recruitment. According to Ministry of Labour figures, during the first nine months of last year the number of boys offered apprenticeships or " learnerships " was over 4 per cent higher than in the comparable period of 1958. Although this has not kept pace with the increase of 8 per cent in the number of boys taken into employment generally, it does show an upward trend. The British Employers' Confederation says its concern is to see that this upward trend continues.

Post Office Student Apprenticeships

An apprenticeship scheme to train young men for key engineering posts in connection with mechanisation and automation is being launched this year by the General Post Office. Under this scheme it will guarantee university training or a Diploma in technology course at a College of Advanced Technology to about twenty students from schools. Student apprentices will be selected from young men of British nationality who are between the ages of seventeen and twenty on June 1 in the year when apprenticeship starts. They must have obtained a good General Certificate of Education at ordinary level, and at least three subjects, including mathematics and physics, at the advanced level ; or they must have good prospects of obtaining these subjects in the summer of the year when apprenticeship starts. In all cases headmasters will be asked whether applicants have the ability to reach honours standard in their university studies.

Apprenticeships will last four and a half years, except in Scotland or Northern Ireland, where they will be slightly longer to allow for the duration of university courses. The Post Office will pay university fees, college union dues and the costs of examination and examination registration. In addition, half the cost of essential textbooks will be met. During the student apprenticeship, including the time of attendance at university or college, salaries will be paid according to age and varying from £270 per annum at seventeen to £430 at twenty-one and over.

PERSONAL AND BUSINESS

Appointments

ROTARY HOES, Ltd., has appointed Mr. A. McKay as its new representative for Scotland.

MR. W. H. TYCE has been appointed South Wales area sales agent for Soag Machine Tools, Ltd.

MR. WALTER PAUL YANESKE has been appointed technical director to Toledo Woodhead Springs, Ltd.

UNION CARBIDE, Ltd., announces the appointment of Mr. H. Cawley to the position of Sheffield area sales manager.

MR. GEOFFREY B. ASHTON, A.M.I.Mech.E., has been appointed joint assistant managing director of Higgs Motors, Ltd.

MR. S. H. IRELAND has been appointed assistant managing director of the Consolidated Pneumatic Tool Company, Ltd.

GUY MOTORS, Ltd., announces that Mr. J. J. Parkes and Mr. Arthur Chamberlain are to join its board of directors.

CENTRAL ELECTRICITY GENERATING BOARD has announced the appointment of Mr. C. Donaldson as superintendent of Stella North Power Station.

LONDON MIDLAND REGION, BRITISH RAILWAYS, announces that Mr. K. S. Martin, A.M.I.C.E., has been appointed assistant civil engineer at Euston.

MR. R. E. F. SYKES has been appointed general manager of Griffin and George (Laboratory Construction), Ltd., in succession to Mr. A. E. Lambert who has retired.

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION has announced that Mr. S. S. Carlisle, A.M.I.E.E. head of the physics department, has been appointed an assistant director.

MR. J. A. GODDARD, director and secretary of Fry's Diecastings, Ltd., has been elected chairman of the Zinc Alloy Die Casters Association for 1960. He succeeds Mr. K. J. Whitehead.

IBM UNITED KINGDOM, Ltd., has announced the appointment of Mr. K. R. Barge as director of data processing sales, European area, at IBM world trade Europe headquarters in Paris.

MR. J. S. BRIGHT has been appointed service manager of C.A.V., Ltd. Mr. C. W. Billington will continue as service manager for the United Kingdom and will be responsible to Mr. Bright.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, Ltd., announces that Mr. D. T. Hollingsworth, M.I.E.E., has joined the board of directors and has been appointed joint deputy chairman.

MASSEY-FERGUSON announces that Dr. B. F. Willetts, A.M.I.Mech.E., has been appointed chief engineer, United Kingdom, and Mr. Charles Hunt, A.M.I.Mech.E., has been appointed chief test engineer.

ROLLS-ROYCE, Ltd., announces that Lt.-Col. L. F. R. Fell, M.I.Mech.E., has been appointed a consultant to the company on railway matters to act in an advisory capacity on current and future railway traction projects.

MR. T. H. KIRKUP, joint managing director of The Limmer and Trinidad Lake Asphalt Company, Ltd., has been appointed chairman of The Natural Asphalte Mine-owners and Manufacturers Council in succession to Mr. C. W. Argent.

MR. G. P. THOMPSON, until recently manager of the transformer factory at Rugby works, has been appointed manager—manufacturing, A.E.I. Rugby, Ltd. He has been succeeded as manager of the transformer factory by Mr. R. Thomson.

MR. ALEX. DORMER, chairman and joint managing director of the Sheffield Twist Drill and Steel Company, Ltd., has been appointed second vice-chairman of the Gauge and Tool Makers' Association, to fill the vacancy caused by the death of Mr. H. G. Carmichael Wilson.

THE SUPERHEATER COMPANY, Ltd., announces that Mr. Eric A. Robinson, chairman and joint managing director, has retired from the position of joint managing director but remains chairman. Mr. L. C. Southcott, joint managing director, has become managing director.

THE BRITISH BROADCASTING CORPORATION has announced that The Hon. R. T. B. Wynn will retire on April 19 from the position of chief engineer, after thirty-four years' service with the Corporation. He will be succeeded by Mr. F. C. McLean, deputy chief engineer, who will have the title of deputy director of engineering. The post of deputy chief engineer will be abolished.

BIRMID INDUSTRIES, Ltd., announces the following appointments in its subsidiary companies: Birmetals, Ltd., and Birmabright, Ltd., Mr. W. C. Jordan, deputy managing director, has been appointed joint managing director ; Mr. R. T. Raven, works director, has been appointed director and general manager ; Mr. C. J. Smith, works metallurgist, becomes technical director. Sterling Metals, Ltd., Mr. T. Player, manager—iron division, has been appointed a director.

MR. G. L. KNIGHT has been appointed assistant to the director of the Scientific Instrument Manufacturers' Association of Great Britain. He will operate under the director, Captain R. A. Villiers, in the field of information and external activities in particular, and will also be responsible for the collection and distribution of information for S.I.M.A. Mr. Knight is available to answer all general questions at S.I.M.A. House, Queen Anne Street, London, W.1 (Langham 4251). The Instrument Inquiry Service is still at Imperial 6000.

Business Announcements

RYMAG, Ltd., has moved to 197, Knightsbridge, London, S.W.7 (telephone, Knightsbridge 9206-9).

BROOK MOTORS, Ltd., states that its Bristol branch office has moved to the Refuge Assurance Building, 18, Baldwin Street, Bristol, 1.

EDWARD WOOD AND CO., Ltd., has transferred its London office to 78, Buckingham Gate, London, S.W.1 (telephone, Abbey 1948-9).

THE ACROW GROUP OF COMPANIES has announced the completion of negotiations for the acquisition of the whole of the issued capital of Thomas Storey (Engineers), Ltd.

CONTINUOUS CASTING COMPANY, Ltd., Netherby, 161, Queens Road, Weybridge, Surrey, announces an agreement for technical collaboration with Low Moor Alloy Steelworks, Ltd., of Bradford.

AIRMEC, Ltd., has opened a new Birmingham show room at 11, Union House, Union Drive, Sutton Coldfield. The show room will be in charge of Mr. D. T. Wilson, Midlands technical representative.

MR. AMBROSE CONGREVE, chairman of Humphreys and Glasgow, Ltd., has left by sea for a six weeks business tour of the United States. He will also visit the Toronto headquarters of the associate company, Humphreys and Glasgow (Canada), Ltd.

GANDY, Ltd., of Wheatland Works, Wallasey, Cheshire, informs us that it was not the Birkenhead firm referred to at the recent inquiry into the cause of a disaster at the Auchengeich colliery as having supplied 80ft of belting which was sub-standard.

MR. C. R. DARWELL, export manager of Fredk. Braby and Co., Ltd., has left by air for Ghana for the first stage of his African tour. He will be away for approximately one month and has arranged to visit Fredk. Braby and Auto Diesels African agents.

MICROCELL, Ltd., states that its commercial engineering division has been formed into a subsidiary company known as Microcell Engineering, Ltd. The members of the board are Mr. Henry Kremer, Mr. J. J. Molins, Mr. L. R. Rutherford, Mr. L. Avis, technical director, and Mr. D. J. Dolamore, works director.

FIRTH CLEVELAND INSTRUMENTS, Ltd., announces that A/S Garek, of Oslo, has been appointed Norwegian representative for the Gilbarco-Firth Cleveland electronic tank contents gauge. The new appointment is additional to the existing arrangements between Simmonds Aerocessories, Ltd., and Firth Cleveland Instruments, Ltd., and A/S Haneborg and Fleischer of Oslo.

METAL PROPELLERS, Ltd., Croydon, Surrey, states that it has acquired the Standard Steel Company (1929), Ltd. Mr. C. Colley, managing director of Metal Propellers, has been appointed managing director of Standard Steel. Mr. D. R. Morgan, who will continue as a director of Standard Steel, has been appointed general manager of that company, and a director of Metal Propellers.

RICHARDSONS, WESTGARTH AND CO., Ltd., has announced the formation of a subsidiary company, Richardsons, Westgarth Inc., with offices in Washington, D.C. The new company will act as selling agent in the United States for products made by the company in this country and will also be able to act as main contractor where plant is made in the U.S.A. to Richardsons, Westgarth designs.

MASCHINENFABRIK AUGSBURG-NURNBERG A.G., states that, following the conclusion of a skeleton agreement with D.I.N.I.E. (Direccion Nacional de Industrias del Estado), sanctioned by the Argentine Government, a new company has been formed, the Industrias Argentinas M.A.N., Soc. An., Industrially Commercial. The new company will be concerned primarily with the manufacture of diesel engines.

BALDWIN INDUSTRIAL CONTROLS, BALDWIN INSTRUMENT COMPANY, Ltd., Lowfield Street, Dartford, Kent (a member of the Harper Engineering and Electronic Group), announces the formation of a hydraulic servo division in order to offer industry a comprehensive service for the application of hydraulic servo techniques to problems of production and experimental engineering. Mr. J. C. Wells has been appointed chief engineer of the division.

THE VAUGHAN CRANE COMPANY, Ltd., West Gorton, Manchester, 12, announces that it has formed a joint venture company in conjunction with Burn and Co., Ltd., Howrah, West Bengal, and Martin Burn, Ltd., Calcutta, India, to manufacture mechanical handling equipment including overhead electric and hand-operated travelling cranes and hoist blocks. The new company is the Vaughan Burn Crane Company Private, Ltd., Martin Burn House, 12, Mission Row, Calcutta, 1. P.O. Box No. 28.

THE BUREAU VERITAS MARITIME REGISTER has been revised in order to make its use more convenient and improvements have been made in the general presentation of the information supplied and the appendices. In future the particulars for each vessel will be printed on a single page and all ships will be grouped in alphabetical order, although inland navigation ships will appear in a separate booklet. Orders may be placed with the British Central Office of Bureau Veritas, Winchester House, Old Broad Street, London, E.C.2.

Contracts

MITCHELL ENGINEERING, Ltd. (Mechanical Handling Department), has been awarded a £2,000,000 contract by Richard Thomas and Baldwins, Ltd., for mechanical handling equipment for the new Spencer Steel Works at Llanwern, near Newport. The contract covers ore and coal screening, crushing and conveying machinery and storage plant. Work has already started and is due to be finished by March, 1961.

SOUTH DURHAM STEEL AND IRON COMPANY, Ltd., announces that a contract with the Esso Petroleum Company, Ltd., has been successfully negotiated for 100 miles of 30in diameter steel pipes for the development of the oilfields in Libya. The value of the contract, consisting of 23,000 tons, is approximately £1,430,000. Manufacture of the steel pipes is due to commence in April next and delivery is required to be completed by September, 1960.

SIMON-CARVES, Ltd., has received from Richard Thomas and Baldwins, Ltd., a contract of approximately £3,750,000 for the coke ovens and by-product plant of the new hot strip mill to be built at the Spencer Works at Newport, Monmouthshire. The plant will comprise 140 ovens capable of carbonising approximately 2860 tons of dry coal per day, together with a by-product plant to recover tar and crude benzole and to produce sulphate of ammonia. Work on the site is expected to begin early this year. The first stage of the plant will be in production in September, 1961, and the remainder will go into production a month later.

THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD has placed contracts for a new power station on the eastern shore of Loch Ericht, some 10 miles south of Dalwhinnie. The contract for building the station and allied civil engineering work has been placed with A. A. Stuart and Son (Glasgow), Ltd. The plant, a 2200kW turbo-induction generator, will be supplied by Bruce Peebles and Co., Ltd., Edinburgh. The turbine will be manufactured by The Armfield Hydraulic Engineering Company, Ltd., as sub-contractor. The new power station will stand at the outlet of the existing tunnel from Loch Garry to Loch Ericht, part of the Rannoch section of the Grampian power scheme, with a maximum head of 196ft, and will produce 10,300,000 units of electricity annually. The civil engineering consultants for the works are Sir Alexander Gibb and Partners.

CONTINENTAL AFFAIRS

by Our Continental Editor

Short Take-Off and Landing Aircraft

FLIGHT trials are at present in progress of a novel short take-off and landing aircraft developed by the Dornier Works, Munich-Neuaubing. While no results regarding performance in these tests have yet been released, the machine itself, the "Do 29," is of great technical interest. Like the "Do 28," which was first shown in public last June at the Salon Internationale de l'Aeronautique at Le Bourget, it derives from the well-known "Do 27." The "Do 28" (Fig. 1) is basically a twin-engined version of the earlier design, using about 80 per cent of its components. An unusual aspect is the manner in which both engines and undercarriage are attached by means of stub wings. While the "Do 27" was conceived as a multi-purpose aircraft, its successor, by virtue of its increased power reserve and operational safety, is more specifically intended as a private passenger transport.

With the "Do 29," a new departure is being made. The aircraft, which still uses 70 per cent of the "Do 27" components, is equipped with two inclinable airscrews in order to obtain a greatly increased lift during take-off. In order to avoid blowing down on the upper surface of the wing, which would result in a loss of lift, the airscrews are arranged as pushers. The three-bladed, large diameter, variable pitch propellers are synchronised and rotate in opposite directions. While the power units remain fixed, the transmission is arranged so that the airscrews can be tilted downwards through nearly 90 deg., an idea suggested during the war by Professor Focke in his design for the Focke Achgelis FA 269: it contrasts with the arrangement of the "Do 26" flying-boat, on which the propellers were tilted up to be clear of spray. Our illustration, Fig. 2, shows the "Do 29" on the tarmac with the propellers in the normal position. A comparison of the principal data of the "Do 27," "Do 28," and "Do 29" is given in Table I.

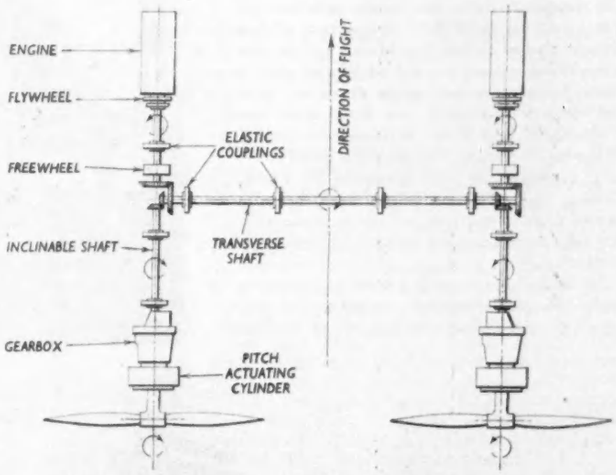


Fig. 3—Transmission of "Do 29" STOL aircraft (diagrammatic)

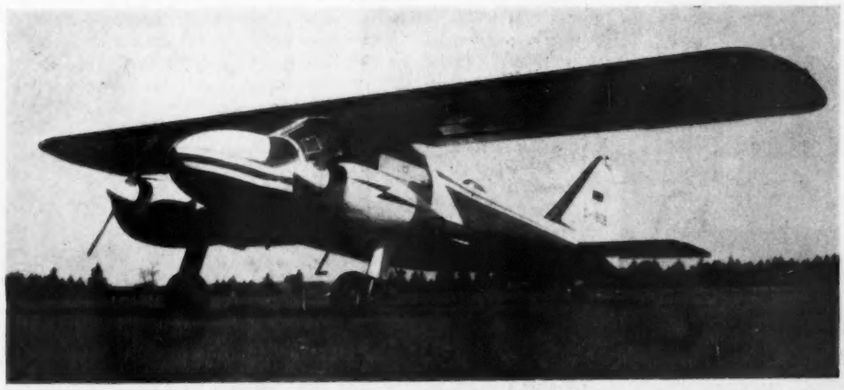


Fig. 1—The "Do 28," a twin-engine version of the "Do 27," is intended as a six-seater passenger aircraft

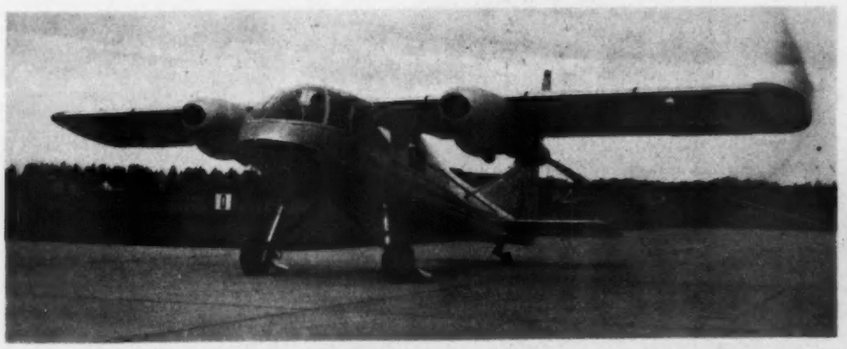


Fig. 2—Prototype "Do 29" on the tarmac. As in the "Do 27," the leading edge is provided with a fixed slot over the whole length of the wing. The design of the fixed nacelles suggests later replacement of the piston engines by turbines. The rear sections with the airscrews, together with the flaps, can be lowered through almost 90 degrees

TABLE I—*Basic Data of Recent Dornier Aircraft*

	Do 27A[1]	Do 28	Do 29[2]
Length	9·6m	9·6m	—
Height (without screw)	2·7m	—	—
Span	12m	11m	13·2m
Wing area (gross)	19·4 square metres	19·4 square metres	21·7 square metres
Wing loading	77·5 kg per square metre	—	109·8 kg per square metre
Weight empty	985 kg	—	—
Weight loaded	1570 kg	—	2400 kg
Power plant	275 h.p. Lycoming GO-480-B1A6	Two × 180 h.p. Lycoming O-360-A1A	Two × 275 h.p. Lycoming GO-480-B1A6
Maximum speed	255 km per hour	—	—
Cruising speed	205 km per hour	—	290 km per hour
Stalling speed	58 km per hour	—	Approx. 25 km per hour[4]
Take-off distance	165m[5]	—	Approx. 25m[4]
Landing distance	102m[6]	—	Approx. 15m[4]
Range	870 km – 1425 km	—	800–1200 km
Cabin	3·5 cubic metres	—	—
Number of occupants	5	4–6	—
First flight	June 27, 1955	April 29, 1959	December, 1958[3]

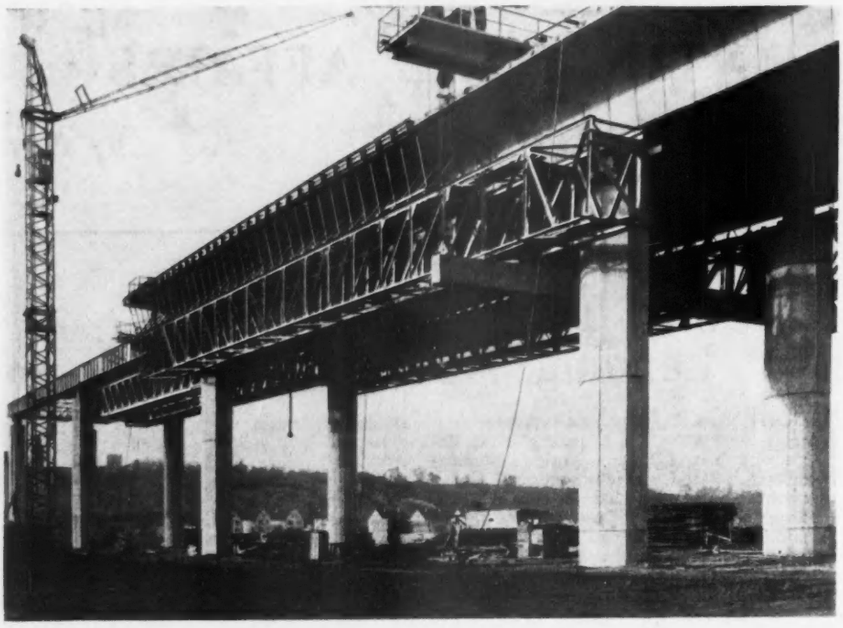
[1] Principal military version. Altogether, seven military, civil, and mixed versions have been built which differ somewhat in dimensions, layout, load capacity (up to six occupants), and power plant (230 h.p.–340 h.p.).
[2] Prototype.
[3] With fixed propellers.
[4] Design value.
[5] To clear 15m.
[6] From height of 15m.

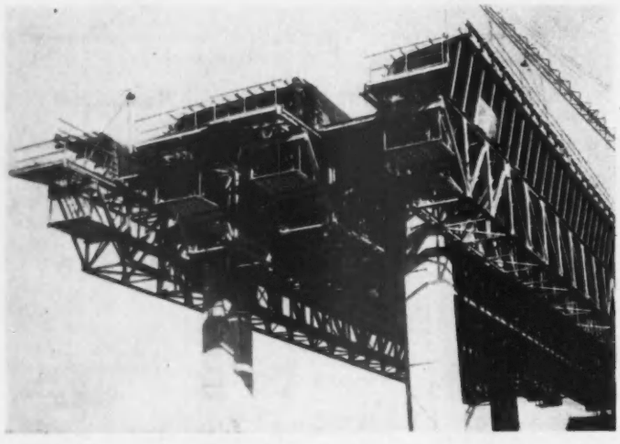
The transmission is shown diagrammatically in Fig. 3. Through freewheels and bevel gearing, the two engines are connected to a common transverse shaft which in turn drives the propeller gearboxes. In this way, the two propellers counter-rotate in synchronism; at the same time they can be driven by either engine on its own should the other fail. Elastic couplings ensure the required amount of flexibility both in bending and in torsion. The rear sections of the engine nacelles, with the propeller drive shafts, gearboxes, variable pitch actuating cylinders, and the propellers themselves, can be rotated by hydraulic actuators about the centre line of the transverse shaft, down to a near-vertical position. The flaps are connected to the same mechanism and move in conjunction.

Kettig Viaduct

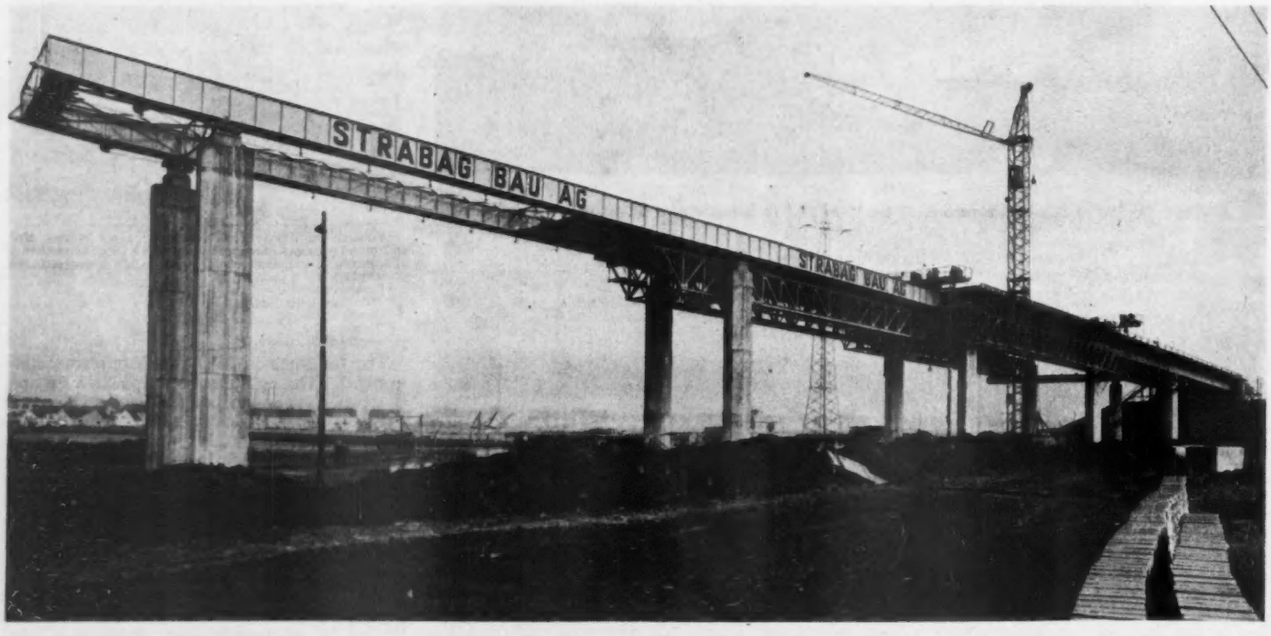
The Weissenthurm-Andernach by-pass on the German route B9 which is at present being built for the Strassenverwaltung Rheinland-Pfalz (the Rhineland-Palatinate Highway Authority) includes a viaduct with thirteen continuous spans each of 39·2m, for which a novel method of construction has been introduced. Each span comprises two box beams of prestressed concrete, connected together by the road slab at the top level, the slab also cantilevering out beyond each beam to give a total width of 18m. Shuttering is carried on four trussed girders, and when a span is complete, these girders are moved forward to the next span, using a steel girder device which, in the ensuing description, we have called the "traveller," since it can be moved over rollers at the column heads. This system of construction was developed by the contractor at Kettig, Strabag Bau A.G., and is clearly advantageous where there is repetition and where the columns are tall ; in this case the maximum column height is 25m.

With the four trussed girders in position, a new span plus a cantilever extending forwards about 6m is cast, and then prestressed. At this





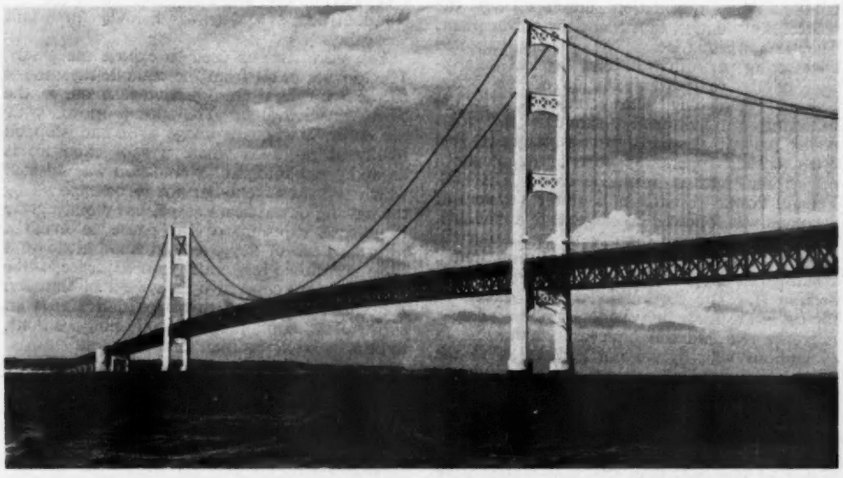
stage the traveller, which is 81·43m long, is positioned ahead, on the tops of the columns completed previously, clear of the beam construction. When the newly-built span and cantilever are prestressed, however, the traveller is moved back until it abuts on to the completed work. The shutters are struck by synchronised hydraulic jacks which "inch" the shutters and shuttering girders down together, and finally the two soffit shutters of the box beams, which are hinged, flap down. The inner pair of shuttering girders is then moved forward ; for this they are carried by two crabs which roll forward on the permanent work and on the beams of the traveller. After a short initial movement, the rear crab carries the girders from a cross beam, but they are suspended directly from the forward crab. The shuttering girders are "landed" on the octagonal shelves of the next pair of columns, below the column-head rollers. This stage is well shown in the LOWER illustration, with the crabs in position to lift the two outer shuttering girders, prior to moving them forward to complete the operation. The same stage is shown in the UPPER view, in which the soffit shutters hanging on the outer girders are clearly seen. The CENTRE view shows the shutters nearly ready for concrete at the cantilever end. The rate of construction is one cycle per fortnight, i.e. 78·4m of deck per month. The superstructure is prestressed on the B.B.R.V. system. The firm considers that the most economical range of spans for this system is 25–30m.

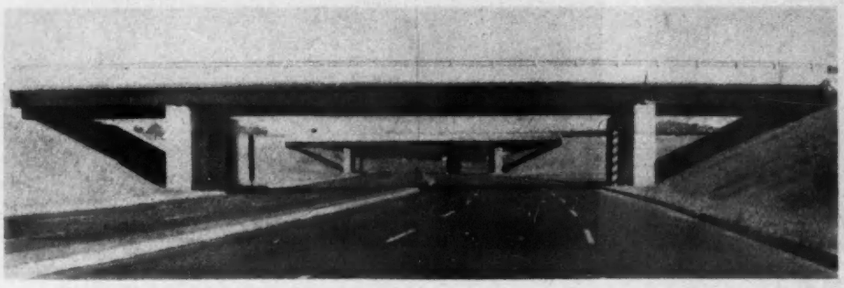


THE AMERICAN SCENE

by Our American Editor

Annual Steel Bridge Competition





THE "most beautiful" steel bridges opened to traffic in the United States during 1958 were recently announced in the annual competition sponsored by the American Institute of Steel Construction. A jury selected thirteen bridges in eleven states from 104 entries, the largest number of bridges ever submitted in the thirty-one-year-old bridge competition. Mr. M. G. Gaskin, the chairman of the A.I.S.C. Committee on Awards, said: "The committee is gratified by the large number of entries received this year, particularly from state highway departments and bridge engineers, which indicates an increasing interest in the use of structural steel for its strength, durability and æsthetic possibilities." The winners are illustrated here.

The first illustration (Class I Award, for bridges with spans of 400ft or more) shows the Mackinac Bridge, Mackinac Straits, Michigan. Owner, Mackinac Bridge Authority; designer, D. B. Steinman; fabricator, American Bridge Division, U.S. Steel Corporation. The jury praised this "monumental structure" for its "strength, handsome silhouette and the beauty it gains from its noble proportions and mass." The second picture (Class II Award, for bridges with fixed spans under 400ft and costing more than 500,000 dollars) shows the Louie Morris Memorial Bridge, over the Savannah River on U.S. Highway 29, about 8 miles east of Hartwell, Georgia. Owner, Corps of Engineers, U.S. Army, for the State of South Carolina; designer, Patchen, Mingledorff and Williams; fabricator, Calvert Iron Works, Incorporated. It was "the contrast between the lithe steel spans and the simple muscular piers, giving an athletic feeling combined with a sturdy rhythm" that appealed to the jury. The third picture (Class III Award, for bridges with spans under 400ft, costing under 500,000 dollars) shows Norwood, bridges N–25–22 and N–25–23, Rotary over Route 1, Providence Turnpike, Massachusetts. Owner, Commonwealth of Massachusetts; designer, Bridge Division, Massachusetts Department of Public Works; fabricator, Tower Iron Works, Incorporated. The jury applauded "the straightforward solution and its pleasing proportions that expresses a synthesis of the best in highway overpass design."

Uniform Procedure for Use in the Evaluation of Nuclear Power Reactors

OVER the last few years significant progress has been made towards the goal of developing nuclear reactors capable of producing competitive electrical power. A need on the part of government and industry has become increasingly apparent for a uniform procedure which would be helpful in evaluating various reactor concepts and reactor systems. Therefore, in May, 1959, the Atomic Industrial Forum asked Mr. Titus LeClair, Manager of Research and Development of the Commonwealth Edison Company, to undertake a study with the hope that a uniform procedure could be established. Mr. LeClair in turn invited three other experts in the reactor and power field to join him in this endeavour.

The uniform procedure for evaluating reactor concepts and reactor systems which is contained in this report is, of necessity, based on information currently available. Every attempt has been made to make the uniform procedure proposed applicable to as wide a variety of reactor types as possible and to avoid anything in the procedure itself which would unfairly weight the procedure in favour of one reactor type or concept over another. But only experience in the use of the proposed procedure will

THE AMERICAN SCENE *(Continued)*

determine the extent of its comprehensiveness and applicability.

Members of the Atomic Industrial Forum have recognised the need for a uniform procedure or form for presenting the design data pertaining to a reactor under evaluation, for outlining its anticipated cost performance, and for describing both the current state of its development and the additional developmental requirements. It is hoped that the new form will find general acceptance by the electrical utilities, builders, the U.S. Atomic Energy Commission and others interested in the development of nuclear power. The form is intended primarily for use in describing the first full-scale plant evolving from a reactor concept. It may also, however, be used to describe reactors at other stages of development ; e.g., a prototype plant or a " second generation " plant. The primary objective in preparing this form was to provide a uniform basis for comparing the merits of different reactor concepts. Two types of comparisons are visualised as being typical :

A. General comparative evaluation of different reactor concepts.

B. Specific analysis to select the optimum concept for a particular application, site or utility system.

For the first comparison it is urged that the reference site, assumptions and prices given be employed. For the second evaluation, specific site data and financial criteria will usually be available to the evaluator and should be used. However, in order to make the results of such an evaluation of maximum value for comparative purposes to all interested parties, he should specify the site and financial criteria which was used.

In addition to facilitating reactor comparisons, the form can serve as a guide in making a critical evaluation of the potential of any reactor concept. A review of a concept at progressive stages of the research and development programme can assist in directing the programme towards maximum benefits. On the other hand it may reveal technological difficulties, total power costs not competitive with other reactor concepts, or the need of large amounts of money to complete the r. and d. programme. Any one or a combination of these items may indicate to the person making the evaluation that further work is not justified. Not all reactor concepts should be expected to reach the full scale construction stage. No embarrassment should be attached to the abandonment of a reactor concept, because the elimination of the least promising reactors is as important to progress at this stage of the industry as the development of the most promising types.

In general, the form consists of five sections pertaining to the technical, economic and developmental aspects of the reactor under consideration and four appendices providing explanatory information and recommended criteria for use in the evaluation. Section I identifies the reactor concept with a summary of the basic characteristics. Section II summarises the technological and economic status of the concept at the time the evaluation is made and indicates the amount of time and money required for completion of its development. Section III contains the information developed in the technical evaluation of the nuclear power plant. The data include design parameters, expected engineering performance, and physical description of the major components of the plant. Section IV, dealing with economics, has the following subdivisions : summary of total power costs ; capital cost estimates ; fuel cycle costs ; operating costs ; maintenance costs ; and nuclear insurance costs. The U.S. Federal Power Commission's uniform system of accounts was followed to the extent applicable. Section V serves as a guide in evaluating the proposed research and development programme, treating this subject in greater detail than does Section II. The appendices provide directions for using the foregoing sections and stipulate a reference site and economic criteria for use in evaluations which have not progressed to the point of selecting a specific site. In addition, a glossary is included to define certain terms which are subject to various interpretations.

The form is published as a forty-four-page manual and can be obtained from the Atomic Industrial Forum, 3 East 54th Street, New York 22, New York, at 1.50 dollars.

Photo-Optical Memory System With Automatic Plate Processor

PHOTOGRAPHIC plates used in the permanent memory of an experimental electronic telephone switching system are now being exposed and developed automatically at the Bell Telephone Laboratories. The permanent memory stores such things as directory information and instructions for the electronic switching system. This information is in the form of thousands of clear dots on an otherwise opaque photographic area 2in square. Seventeen areas are used together to make up a complete photographic plate, and the entire permanent memory store consists of four such plates. The spots of clear and opaque film are scanned by a beam which is generated by a cathode-ray tube and focused by a system of lenses. This operation gives rise to the name of the unit—" Flying Spot Store." The movement of the beam is controlled by an electronic and optical positioning system, which must be accurate enough to pick out on each area a particular spot location. The flying spot store contains over 2,000,000 bits of information as opaque or transparent spots and can read out a sixty-eight-bit word (i.e. sixty-eight spots simultaneously) every two-and-a-half microseconds. Random access to any word adds important versatility.

The store itself is used to expose the plates. The moving beam from the cathode-ray tube is focused through an objective lens on to the photo-sensitive area. The spot is moved over the entire 2in square image area and stopped briefly at positions where a spot exposure is desired. A photographic emulsion was selected which is " slow " enough not to be exposed by the passing of the beam alone, but requiring the lengthened exposure of the pause to make a record. Each of the seventeen small areas on a plate is exposed individually, in sequence, while the others are covered by a system of shutters. Automatic control of this operation allows an entire plate, containing 550,000 spot positions, to be exposed in less than three minutes.

After exposure, the plates are withdrawn from the memory unit in a dust- and light-proof container and inserted into the automatic processor for developing and fixing. Two of the plates can be processed simultaneously. Once the plates are inserted in the processor, they are automatically carried through a number of steps. They are dipped into one tank after another, depending on a predetermined schedule. As many as fifteen steps may be involved in a typical reversal processing schedule, and appropriate dwell times are also set to allow proper processing. After developing, reversal and fixing operations have been completed, the plates are rinsed and dried in filtered air and delivered back into their container for reinsertion into the memory unit. The time required for a complete developing schedule is less than a half-hour. Once the machine has been put into operation, it will continue through its sequence without interruption. The machine has been made simple to operate since it is expected that personnel unfamiliar with photographic procedures will operate it.

Fig. 1—Optical system of the flying spot store for an electronic telephone switching system

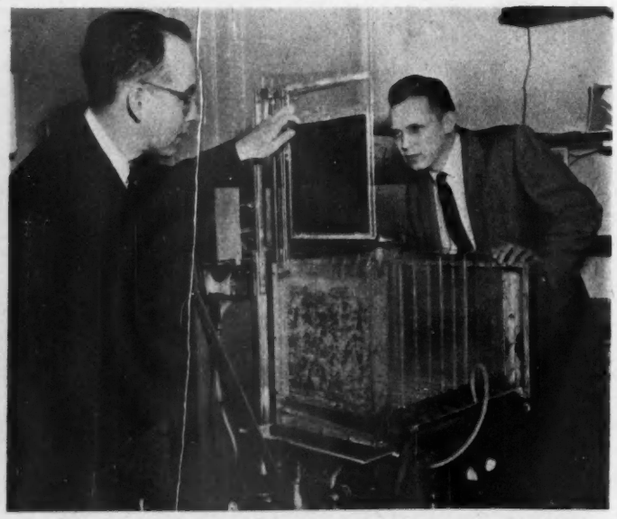


Fig. 2—Automatic processing unit for the photographic memory plates arranged to dip the plates into the various tanks in a predetermined cycle

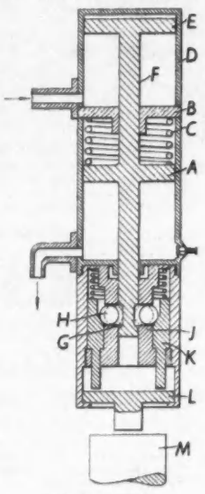
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

CIRCUIT-BREAKERS

826,444. June 11, 1958.—LIQUID-BREAK CIRCUIT-BREAKERS, A. Reyrolle and Co., Ltd., Hebburn, County Durham. (*Inventor: Robert William Wild.*)

This invention relates to liquid-break circuit-breakers having a cylinder with a piston resiliently loaded, retained by means of a latch, so that when the latch is released liquid from the cylinder will be injected into the arc path. The arrangement in accordance with the invention relieves the circuit-breaker tripping latch, the movable contact members and the associated train of mechanism of the load of the oil injection spring, which may be comparable with that of the circuit-breaker kick-off springs. In the embodiment illustrated, there is interposed between the main piston *A* and the top *B* of the cylinder a powerful helical compression spring *C* which applies pressure to the liquid in the cylinder. Above the main cylinder is an auxiliary cylinder *D* containing an auxiliary piston *E* connected to the piston *A* through a piston rod *F*. Compressed air can be admitted through a pipe to the underside of the piston *E* in order to compress the spring and charge the oil pump ready for use. The piston rod extends down below the piston *A* through the bottom of the main cylinder and has near its lower end an annular latching groove *G* to receive a number of latching balls *H*. These are housed in radial bores in a fixed sleeve *J* and are surrounded by a movable latching sleeve *K*. This is pressed downwards by a light latch spring. The latching sleeve is arranged to be operated by movement of the moving contact. Accordingly, its lower end is arranged to be engaged by a tappet *L* with which a part *M* connected to the moving contact comes into engagement as the moving contact reaches its closed position. Conversely, the moment the moving contact starts to move away from its closed position, the tappet travels down to the position shown and allows the latch spring to release the latch and cause the oil to be injected into the turbulator through the outlet. The latch spring is quite light, so that a negligible additional load is imposed upon the moving contact and its latching mechanism. The injection pump described may be incorporated in the circuit-breaker integrally with the turbulator, in which case the member *M* may be the moving contact itself.—*January* 6, 1960.



No. 826,444

ROAD TRAFFIC CONTROL

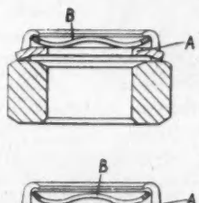
824,781. August 29, 1956.—AUTOMATIC TRAFFIC SIGNALLING SYSTEMS, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1-3, St. Paul's Churchyard, London, E.C.4. (*Inventors: George Shand and George Geoffrey Atkinson.*)

This invention relates to automatic traffic signalling systems, with particular but non-exclusive application to road traffic signalling. It is an object of the invention to provide a flexible traffic signalling system which, while being applicable to the control of a single intersection, is especially advantageous in a progressive, multiple intersection system with centralised programming, in which latter application it can avoid at least some of the limitations and drawbacks of existing schemes. It does this by employing a programme tape or other storing device which is capable of storing long-term programmes. In the simplest case the programme can define the duration of successive holding and clearance periods for a main road at its intersections with a crossing road; this programme information could be translated into the presence and absence respectively of a distinctive marking potential sent on a control wire leading to a programme responding relay at the intersection, which latter could respond to the presence or absence of such marking to control the traffic signals accordingly. At the intersection, at which there would thus be no need for timers to define the clearance and holding ratios, the response of the relay to a change in the marking condition on the control wire would initiate changeover of the aspects presented to the main and cross roads. In employing the invention for co-ordinated control of a plurality of intersections, as in a progressive system, the signal sequences at the several intersections may be governed from a central location under the control of suitable programmes co-ordinating the signal sequence in timing and duration. To provide this control from a central location, signals obtained from the reading apparatus in accordance with programmes relating to several intersections controlled, may be transmitted over separate wires or other communication channels to respective receiving, or "field" stations. Preferably, however, the control location and the several receiving stations would be linked by a single channel over which the control signals intended for the different stations would be transmitted in coded form. A system employing coded signal transmission over a single channel is described in the specification.—*December* 2, 1959.

LOCK NUTS

826,469. July 11, 1958.—SELF-LOCKING NUTS, Simmonds Aerocessories, Ltd., Treforest Trading Estate, near Pontypridd, Glamorganshire, Wales. (*Inventor: William John Burnell.*)

The object of the present invention is to provide an improved method of making a self-locking nut.



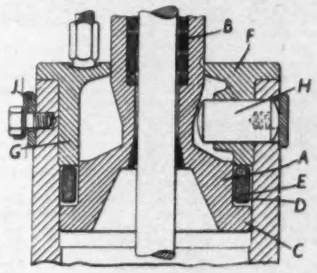
No. 826,469

The accompanying drawings show the nut body with an insert *A* having downwardly extending lugs passing through the slots in the crown of the nut. An undulating spring *B* is held by the inturned edge of the wall of the counterbore which serves to secure the insert and spring in position. After assembly the nut body and insert are tapped simultaneously following which the insert is lowered towards the bottom of the counter bore by flattening the outwardly projecting lugs, as illustrated in the lower view. The thickness of the insert is preferably at least one thread pitch and it may be made of metal or suitable plastics material. Instead of a metal spring there may be employed a ring of rubber or other resilient material.—*January* 6, 1960.

VALVES

826,481. May 4, 1956.—FLUID-PRESSURE CONTROL VALVES, Dewrance and Co., Ltd., 165, Great Dover Street, London, S.E.1.

The invention is described with reference to the accompanying drawing, showing a part of a parallel slide valve in the neighbourhood of the aperture in the valve body for the passage of the valve spindle. The valve body has an aperture fitted with a closure member *A* with a stuffing-box *B* for the valve spindle. The closure member includes a piston-like part *C* slidable in the aperture and having its outer end *D* of reduced diameter for a packing ring *E*. The valve cover *F* has a number of spaced radial bores, each of which holds a bolt *H*, the inner end of which lies within the annular recess in the closure member. The bolts are held in by a ring *J* and do not prevent outward movement of the closure member from the position illustrated as the packing ring is compressed. At the same time the bolts limit inward movement of the closure member to the position shown. In operation, the force exerted on the closure member by the fluid pressure within the valve body acts through the packing ring *E* on the projection *G* of the valve cover, which transmits the force through the bolts *H* to the valve body. It will be seen that in the construction described an economy of parts is achieved, since a single part requiring only one securing means serves both as an annular abutment to take the thrust exerted by the closure member and as a valve operating mechanism support member. The projection *G* and the bolts may be inserted quickly and with little effort and the use of an annular groove in the wall of the aperture is avoided. The construction is suitable for use in valves operating at high pressures and temperatures and is particularly useful if austenitic and ferritic materials are used together.—*January* 6, 1960.

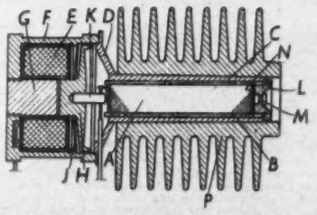


No. 826,481

VOLTAGE REGULATOR

826,450. July 2, 1957.—ELECTROMAGNETIC CARBON PILE REGULATOR, Allmanna Svenska Elektriska Aktiebolaget, Vasteras, Sweden.

In this specification a form of construction for a carbon pile regulator is described in which the radiator cooling device is separate, the pile fitting freely into a hole in the radiator so as to be removable for replacement, repair or adjustment. The drawing shows the pile *A* of insulated discs which is arranged in a tube *B* of insulating material and a surrounding circular metal tube *C*. The metal tube is attached at one end to the electromagnet of the regulator by means of an intermediate member *D*. The electromagnet consists of a coil *E* inserted in a cylindrical magnetic casing *F*, an iron core *G* and a movable armature *H*. Besides the magnetic force the armature is influenced by the opposing force of a spring *J*. The difference between the magnetic force and the spring force is transferred by means of a pin *K* to one end of the carbon pile. The other end of the carbon pile rests against a plug *L* of electrically insulating material, which is screwed into the end of the metal tube *C*. The plug is provided with a central inlet *M* which is in contact with a silver disc *N* situated inside the plug. It is possible to displace the carbon pile and the armature by screwing the plug in or out of the metal tube, whereby the air gap between the armature and the core can be adjusted. Since the metal tube has a smooth outer surface and since the plug, which serves as electric terminal for the carbon pile and adjustment means for the air gap, is arranged entirely inside the metal tube, it is possible, without any special measures to push the carbon pile with the surrounding insulating tube and metal tube, into a circular hole in a separate radiator *P*, which is mounted in any suitable way in the plant which the regulator serves. The outer surface of the metal tube as well as the hole in the radiator, are suitably slightly conical so that an accurate fit is obtained.—*January* 6, 1960.



No. 826,450

Catalogues and Brochures

STENOR, Ltd., Richmond, Surrey.—Illustrated leaflet describing a repair system for rubber conveyor belts.

D. J. EQUIPMENT (HERSHAM), Ltd., 43, Queens Road, Hersham, Walton-on-Thames, Surrey.—Leaflet describing electrical connectors, terminal lugs and clamps made of electrolytic copper.

W. J. JENKINS AND CO., Ltd., P.O. Box No. 3, Retford, Notts.—Folder illustrating and describing the "Teska" washer for cleaning large and medium coal. The washer is manufactured under licence from Schüchtermann and Kremer-Baum, of Dortmund.

EKCO-ENSIGN ELECTRIC, Ltd., 45, Essex Street, Strand, London, W.C.2.—Illustrated leaflet of industrial and decorative fluorescent fittings, and booklets containing details of lamps and tubes and fluorescent control gear and accessories. Prices are included in these publications.

THE CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, Manchester.—Leaflet BW/S–1, "Automatic Sizing with Automatic Wheel Truing and Compensation on Model 'BW' Plain Grinding Machine," and illustrated booklet describing a redesigned centreless grinding machine.

JOHNSON AND PHILLIPS, Ltd., Charlton, London, S.E.7.—Leaflet describing type PDB oil circuit-breaker which is of orthodox double-break design with cross-jet arc-control devices. It has been fully short-circuit tested and certified in accordance with B.S. 116 : 1952 for the breaking capacities specified.

J. COLLIS AND SONS, Ltd., Regent Square, Gray's Inn Road, London, W.C.1.—Leaflet No. 323, describing "The Transveyor," which consists of a hardened steel ball, cradled by 100 smaller balls, in a hardened hemispherical housing. Mounted on vertical steel tubes or on a recessed surface, these units provide a bed on which large objects can be moved easily in any direction.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY Ltd.—Illustrated catalogue (Publication ME/7) describing helical membrane radio-frequency cables, the distinctive feature of which is that a thin insulating helix of polythene (or P.T.F.E. for special high-frequency applications) is spaced on to the inner conductor. The outer conductor is an aluminium tube drawn down over the helix. Cables may be pressurised for improved power and voltage ratings.

CHARLTON, WEDDLE AND CO., Ltd., Manor Works, Newcastle upon Tyne, 1.—Illustrated brochure describing the company's activities in pipework fabrication-installation in marine and industrial fields. Recent contracts have included a complete hull and engine-room pipe installation in a 12,000-ton (dead-weight) dry cargo ship; the conversion of eight edible oil tanks in three Argentine passenger liners, and the fabrication and fitting of conical heating coil installation in an R.F.A. tanker.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ANTIQUARIAN HOROLOGICAL SOCIETY

Thurs., Feb. 11.—Science Museum, Kensington, London, S.W.7, "Pendulum Watches," B. Caillard, and Colour Slides and Film, G. T. E. Buggins, 7 p.m.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Feb. 5.—LIVERPOOL AND DISTRICT BRANCH: Industrial Development Centre, M.A.N.W.E.B., Paradise Street, Liverpool, 1, "Branch Lecturettes," J. L. Blakemore and E. J. Mulholland, 7.30 p.m. ★ STOKE AND CREWE BRANCH: Grand Hotel, Hanley, "Refrigeration," T. Pearce, 7.30 p.m.

Tues., Feb. 9.—GLASGOW BRANCH: Kenilworth Hotel, Queen's Street, Glasgow, C.1, "The National Inspection Council and its Work," E. J. Sutton, 8 p.m. ★ PORTSMOUTH AND DISTRICT BRANCH: Ministry of Labour and National Service, Lake Road, Portsmouth, "The Development of Motor Control Centres," 7.30 p.m. ★ YORK BRANCH: The Georgian House, Blossom Street, York, "Modern Cable-making Materials," D. Pollard, 7.30 p.m.

Wed., Feb. 10.—LUTON BRANCH: College of Technology, Park Square, Luton, "Automatic Operation of Oil-fired Burners," 8.15 p.m.

Thurs., Feb. 11.—BRADFORD AND DISTRICT BRANCH: The Midland Hotel, Bradford, "Recent Developments in Metal Rectifiers," D. Magnall, 7.30 p.m. ★ S.W. LONDON BRANCH: Prince of Wales Hotel, S.W.19, "Protective Equipment for Industrial Plant," W. L. Stern, 7.45 p.m.

BRITISH COMPUTER SOCIETY

Tues., Feb. 9.—MANCHESTER BRANCH: Manchester College of Science and Technology, Sackville Street, Manchester, "Production Planning by Computer," R. B. Baggett, 7 p.m.

Wed., Feb. 10.—BIRMINGHAM BRANCH: Large Theatre, Electrical Engineering Department, The University, Edgbaston, Birmingham, "Models of Stock Control and Production Scheduling," J. W. Harling, 6.30 p.m.

Thurs., Feb. 11.—BELFAST BRANCH: 29, University Square, Belfast, "The Computer in a University," 7.15 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Tues., Feb. 9.—COMPUTER GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Drift Correction of D.C. Amplifiers," D. Leighton Davies, 6.30 p.m.

Wed., Feb. 10.—SOUTH WALES SECTION: Welsh College of Advanced Technology, Cardiff, "Low Noise Low Drift D.C. Amplifiers," V. L. Devonald, 6.30 p.m. ★ NORTH EASTERN SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "Instrumentation in Rocket Propulsion," Raymond E. Ross, 6 p.m. ★ WEST MIDLANDS SECTION: College of Technology, Wulfruna Street, Wolverhampton, "Electronic Reading," I. W. Merry, 7.15 p.m.

CEMENT AND CONCRETE ASSOCIATION

Wed., Feb. 10.—The Building Centre, 26, Store Street, London, W.C.1, Films, 12.45 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs., Feb. 11.—St. Ermin's Hotel, Westminster, London, S.W.1, Discussion on "The Work of the British Coal Utilisation Association towards Improving Mechanisation and Automatic Control in Industrial Coal-Fired Boiler Houses," opened by G. G. Thurlow, 10.30 a.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Feb. 8.—SHEFFIELD CENTRE: Grand Hotel, Sheffield, "Lighting Design," W. Robinson, 6.30 p.m.

Thurs., Feb. 11.—MANCHESTER CENTRE: Demonstration Theatre, Town Hall Extension, Manchester, "Lighting in Relation to Modern Ceilings and Roofs," Derek Phillips, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., Feb. 11.—BEDS AND HERTS SECTION: K. and L. Steelfounders and Engineers, Ltd., Letchworth, Herts, "Use of Epoxy Resins for the Manufacture of Foundry Patterns," H. G. C. King, 7.30 p.m.

INSTITUTE OF FUEL

To-day, Feb. 5.—SOUTH WALES SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "British and Continental Practice in the Fuel Industry," W. Idris Jones, 6 p.m.

Wed., Feb. 10.—NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, 2, "Rocket Fuels," A. D. Baxter, 2.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Feb. 9.—Memorial Building, 76, Mark Lane, London, E.C.3, "Some Crankshaft Failures: Investigations, Causes and Remedies," R. Atkinson and P. Jackson, 5.30 p.m.

Wed., Feb. 10.—SCOTTISH SECTION: Weir Hall, Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, Annual General Meeting; and "Marine Valve Design Developments," J. Tinneveld and J. R. Peacock, 7.30 p.m.

INSTITUTE OF METAL FINISHING

Wed., Feb. 10.—ORGANIC FINISHING GROUP: British Institute of Management, 80, Fetter Lane, London, E.C.4, "Choice of Application Methods for Organic Finishes," E. Podmore and D. W. Hislop, 6.30 p.m.

INSTITUTE OF METALS

Wed., Feb. 10.—17, Belgrave Square, London, S.W.1, "Solidification of Alloys," W. C. Winegard, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Feb. 8.—WEST REGIONAL CENTRE: Liverpool Architectural Society's Rooms, Bluecoat Chambers, School Lane, Liverpool, 1, "Transport Developments in U.S.A., 1957," John F. Moon, 7.30 p.m.

Wed., Feb. 10.—SOUTHERN CENTRE: Polygon Hotel, Southampton, "Movement of Heavy Indivisible Loads," 7.30 p.m. ★ SOUTH EASTERN GROUP: Saracen's Head Hotel, Ashford, "The Development of Automatic Transmission for Commercial Vehicles," R. B. Robinson, 7.30 p.m.

Thurs., Feb. 11.—SOUTH WESTERN GROUP: Rougemont Hotel, Exeter, "Recent Developments in Head Lighting," J. H. Nelson, 7.30 p.m.

Fri., Feb. 12.—SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, "Transport Developments in U.S.A., 1957," John F. Moon, 7.15 p.m.

INSTITUTE OF WELDING

Tues., Feb. 9.—SLOUGH SECTION: Lecture Hall, Community Centre, Farnham Road, Slough "Design for Welding" F. Brooksbank, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Wed., Feb. 10.—EAST MIDLANDS CENTRE: Nottingham University School of Agriculture, Sutton Bonington, Loughborough, Leics, "Forage Harvesters," R. Q. Hepherd, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Feb. 9.—Great George Street, Westminster, London, S.W.1, "The Stresses in Foundation Rafts," D. N. de G. Allen and R. T. Severn, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Feb. 5.—MEDICAL ELECTRONICS DISCUSSION GROUP: Savoy Place, London, W.C.2, Discussion on "Computers in Medical Use," opened by R. A. Buckingham, and J. M. Tanner, 6 p.m.

Mon., Feb. 8.—ELECTRONICS AND COMMUNICATIONS SECTION: Savoy Place, London, W.C.2, Discussion on "Present Views on Ground-Wave Propagation," opened by G. Millington, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Assembly Hall, 3 (Tels.) Training Bn., R.E.M.E., Arborfield, Berks, Film "Electric Traction," 7 p.m. ★ NORTH-EASTERN CENTRE: Neville Hall Westgate Road, Newcastle upon Tyne, "Silicone Electrical Insulation," J. H. Davis, 6.15 p.m. ★ SOUTH MIDLAND SUPPLY AND UTILIZATION GROUP: College of Technology, Gosta Green, Birmingham, "Discrimination between H.R.C. Fuses," E. Jacks, 6 p.m. ★ WESTERN CENTRE: South Wales Institute of Engineers, Cardiff, "The Development of Communication, Indication and Telemetering for the British Grid," G. A. Burns, F. Fletcher, C. H. Chambers and P. F. Gunning, 6 p.m.

Tues., Feb. 9.—NORTH-WESTERN UTILIZATION GROUP: Engineers' Club, Albert Square, Manchester, "Variable Speed Induction Motors," F. C. Williams and E. R. Laithwaite, 6.15 p.m.

Wed., Feb. 10.—SUPPLY SECTION: Savoy Place, London, W.C.2, "The Design of Housing-Estate Distribution Systems using a Digital Computer," R. L. Grimsdale and P. H. Sinclare; and "The Logical Design of Electrical Networks using Linear Programming Methods," U. G. W. Knight, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Visit to the Micanite and Insulators Company, Ltd., Walthamstow, 2 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: N.W.E.B. Demonstration Theatre, Lancaster Road, Lancaster. "The Provision of Adequate Electrical Installations in Buildings—Multi-Storey Flats and Maisonettes," C. A. Belcher, 7.15 p.m. ★ OXFORD DISTRICT BRANCH: S. E. B. Service Centre, 37, George Street, Oxford, "The 'Deltic' Locomotive," C. M. Cock, 7 p.m.

Thurs., Feb. 11.—NORTH SCOTLAND SUB-CENTRE: Electrical Engineering Department, Queen's College, Dundee, "The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 7 p.m.

Fri., Feb. 12.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 7.30 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Technical College, Stoke-on-Trent, "The Provision of Adequate Electrical Installations in Buildings—Multi-Storey Flats and Maisonettes," C. A. Belcher, and "Houses" C. C. Hyams, 7 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, Feb. 5.—LONDON BRANCH: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Some Modern Developments in Highway Bridge Design," C. S. Chettoe, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Feb. 5.—SCOTTISH BRANCH: Technical College, Dundee, "The Importance of Biomechanics as a Service to Man," J. M. Zarek, 7.30 p.m. ★ NORTH WESTERN GRADUATES' SECTION: Visit to Dunlop Rubber Company, Ltd., Cambridge Street, Manchester, 6.15 p.m.

Mon., Feb. 8.—EASTERN GRADUATES' SECTION: Visit to Flowers Brewery, Luton, 7.30 p.m.

Tues., Feb. 9.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, "Construction and Behaviour Characteristics of Tyres," T. French, 6 p.m. ★ EASTERN GRADUATES' SECTION: Visit to Huntley and Palmers, Reading, 2.30 p.m.

Wed., Feb. 10.—EASTERN GRADUATES' SECTION: Queen's Engineering Works, Bedford, Film Show, 7.30 p.m. ★ SCOTTISH GRADUATES' SECTION: South Engineering Building, The University, Glasgow, W.2, "Industrial Development in Scotland," C. A. Oakley, 7.30 p.m.

Thurs., Feb. 11.—STEAM GROUP DISCUSSION: 1, Birdcage Walk, Westminster, London, S.W.1, "The Case for the Development of Steam Turbines up to 10,000kW Capacity for Higher Steam Pressures and Temperatures," 6 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: Technical College, Chesterfield, "Future Trends in Coal Mining Machinery," J. R. Ashley, 7.15 p.m.

Sat., Feb. 13.—LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, Biennial Conversazione, 7 p.m.

INSTITUTION OF PLANT ENGINEERS

Wed., Feb. 10.—DUNDEE BRANCH: Taypark Hotel, West Ferry, Dundee, "Uses of Aluminium in Engineering," 7.30 p.m. ★ EAST MIDLANDS BRANCH: Sherwood Room, County Hotel, Theatre Square, Nottingham, "Building Large Tankers," J. W. Eckhard, 7 p.m.

Thurs., Feb. 11.—NORTH EAST BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "Selection of Electric Motors for Industrial Purposes," H. C. Ruffle, 7 p.m. ★ SHEFFIELD BRANCH: Station Hotel, Chesterfield, "Electronics," J. Siddon, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Tues., Feb. 9.—LONDON SECTION: National College of Rubber Technology, Holloway, London, N.7, "Present Day Manufacture and Use of Reclaimed Rubber," W. E. Stafford and D. Sargent, 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Feb. 5.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Films, "Building with Straw," "Electric Water Heating Installation Practice," and "No Rust Here," 7 p.m.

Mon., Feb. 8.—SHEFFIELD SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, "Structural Plastics in Engineering," R. W. Markes, 7.30 p.m.

Fri., Feb. 12.—NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, "Cosmic Rays," Mr. Wolfendale, Jnr., 7.30 p.m. ★ LONDON SECTION: Pepys House, 14, Rochester Row, London, S.W.1, "Adhesion between Wheel and Rail," F. T. Barwell, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Feb. 11.—College of Technology, Liverpool, Joint Meeting with the Liverpool Section of the Society of Chemical Industry, "Recent Researches in the Corrosion and Protection of Iron and Steel," J. C. Hudson, 7.30 p.m.

PLASTICS INSTITUTE

Wed., Feb. 10.—YORKSHIRE SECTION: St Mark's House, 186, Woodside Lane, Leeds, 2, "Polyester Resin Applications in Industry," K. A. Scott, 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN

Fri., Feb. 12.—21, Albemarle Street, London, W.1, "Fuel Cells: Will They Soon Become Major Sources of Electrical Energy?" F. T. Bacon, 9 p.m.

SOCIETY OF CHEMICAL INDUSTRY

To-day, Feb. 5.—FIFTH IVAN LEVINSTEIN MEMORIAL LECTURE: Large Chemistry Theatre, The University, Oxford Road, Manchester, "The Future of Chemicals from Petroleum," L. H. Williams, 6.30 p.m.

Tues., Feb. 9.—5TH CHANCE MEMORIAL LECTURE: Lecture Theatre, Chemistry Department, The University, Birmingham, "The Development of Siemens Furnaces for Glass Melting," W. M. Hampton, 7 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Thurs., Feb. 11.—CONTROL AND DATA PROCESSING SECTIONS: Manson House, 26, Portland Place, London, W.1, "Measurement, Automatic Control and Data Reduction as Applied to a Cyclic Plant," T. A. Lucas, 6.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Wed., Feb. 10.—Hope House, 45, Great Peter Street, London, S.W.1, "Uses of New Metals," J. G. Ball, 7 p.m.

Advanced Engineering Courses

Refresher Courses for Older Graduates. DEPARTMENT OF METALLURGY, BATTERSEA COLLEGE OF TECHNOLOGY, London, S.W.11. Three- to four-day courses by members of the College staff and visiting lecturers. "The Structure of Metals and Alloys," Easter vacation, April; "Developments in Foundry Practice," Summer vacation, July; "Austenite Transformation—The Present Position," Summer vacation, September.

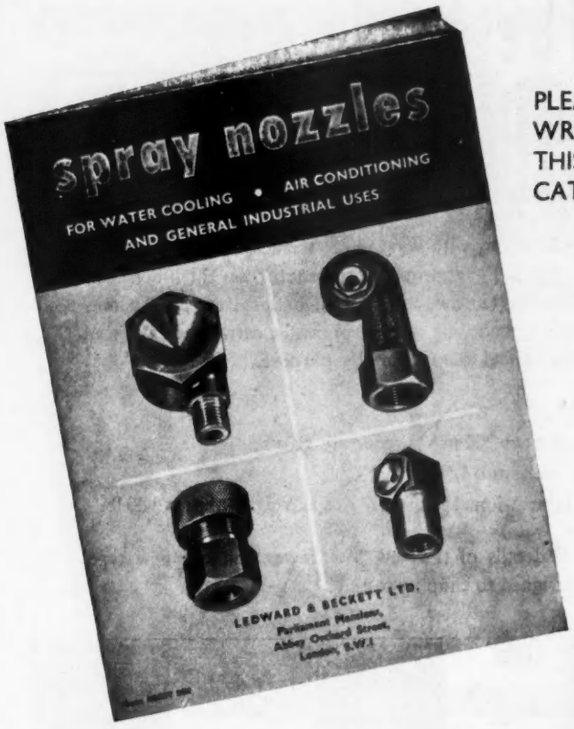
Reactor Fuel Element Technology. DEPARTMENT OF CHEMICAL ENGINEERING AND CHEMICAL TECHNOLOGY, IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, London, S.W.7. A course of ten lectures, forming part of the post-graduate diploma course in nuclear technology (chemical), designed to lay emphasis on the industrial problems of reactor fuel element technology. Thursday afternoons from February 11 to March 17. Fee five guineas.

Organisation and Methods. UNIVERSITY OF BIRMINGHAM, INSTITUTE FOR ENGINEERING PRODUCTION, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. Residential executive course for senior personnel who are either responsible in a general manner for functions which may include organisation and methods, or are intending to enter this field and wish to extend their knowledge of what can be achieved and of the techniques used. The course runs from February 29 to March 18. Fee 85 guineas.

O.E.E.C. Courses on Nuclear Energy for Engineers and Technical Industrialists. Two international courses arranged by the European Nuclear Energy Agency of the O.E.E.C. One course will be at the Centre d'Etudes Nucléaires at Saclay, France, and the other at the Atomic Energy Research Establishment, Harwell. Each course will be open to some fifty participants from O.E.E.C. countries, and will cover the technical, economic and industrial aspects of nuclear energy. The course at Saclay (French language) will take place from June 27 to July 8; the Harwell course, in English, from July 4 to 15. Further information can be obtained from O.E.E.C. European Nuclear Energy Agency, 38, Boulevard Suchet, Paris, 16e.

Secondary Surfaces for Heat Exchangers. NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, St. John Street, London, E.C.1. A course of six lectures for students who are graduates in science or engineering or those with equivalent qualifications. Students will be expected to have a good knowledge of heat transfer. Wednesday evenings at 7 p.m., commencing March 2. Fee £1 1s.

Lubrication and Lubricants. BOROUGH POLYTECHNIC, Borough Road, London, S.E.1. A course of six lectures, intended for engineers of graduate status, and suitable for those holding positions in the design and production aspects of engineering. Monday evenings at 7 p.m., commencing February 22. Fee 10s.



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SPECIFICATION

Energising supply: 5.0 v.; Max. current 200 mA; Frequency 1 Kc/s;
Electrical output ±0.15 mA full scale into 1,500 ohms load;
Mains supply 200-250 v. 50 c/s; Dimensions 15" x 9" x 6" deep; Weight (approx.) 20 lb.

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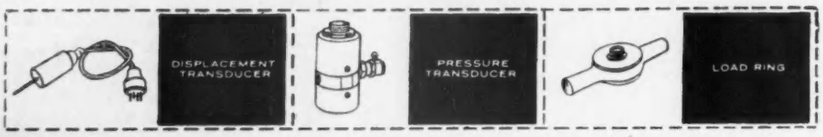

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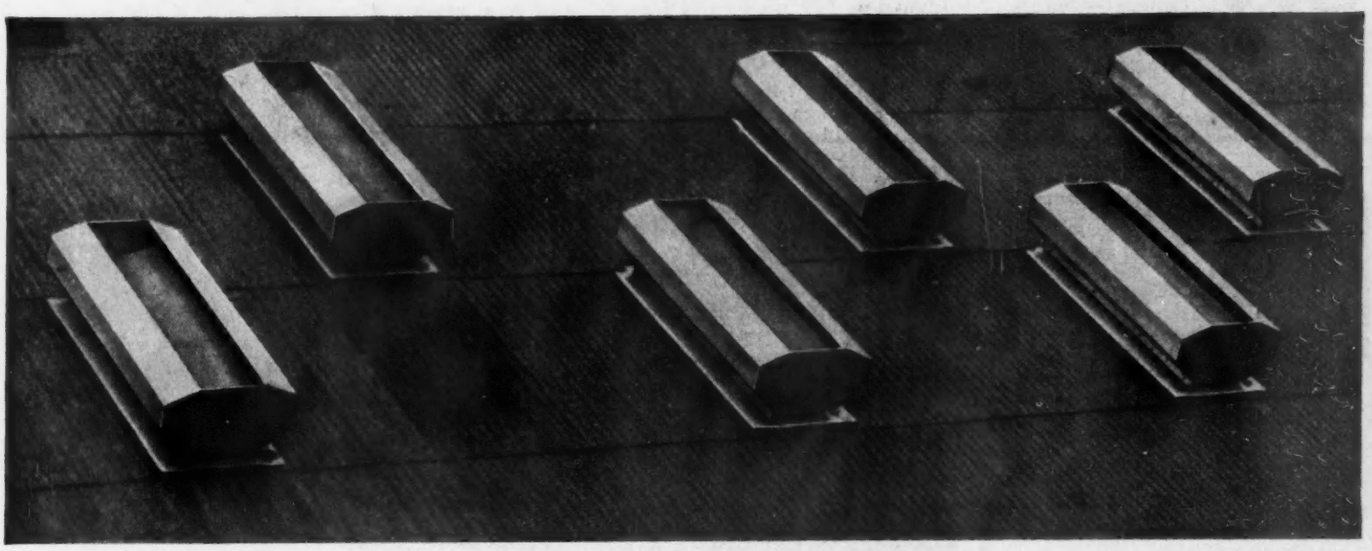
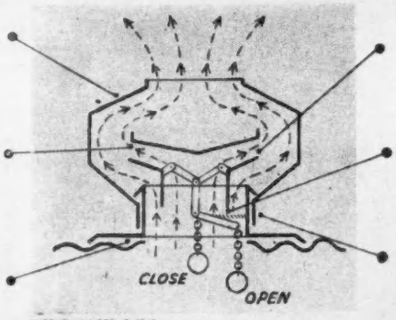


Anti-corrosive aluminium alloy cowling eliminates maintenance.

Baffle and adjustable dampers aerodynamically designed to eliminate turbulence—provide unrestricted outlet.

Base suitable for fixing into patent glazing or roof sheeting.



PATENT NUMBER: 819012

Adjustable dampers remotely controlled with pneumatic, hydraulic or mechanically operated shaft and lever gear.

Hand operated dampers spring loaded—positive snap action into open or closed positions.

Close fitting base eliminates down draughts—gives full protection against weather.

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Power operated ventilating shutters

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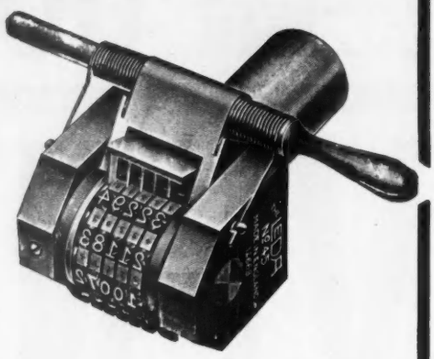

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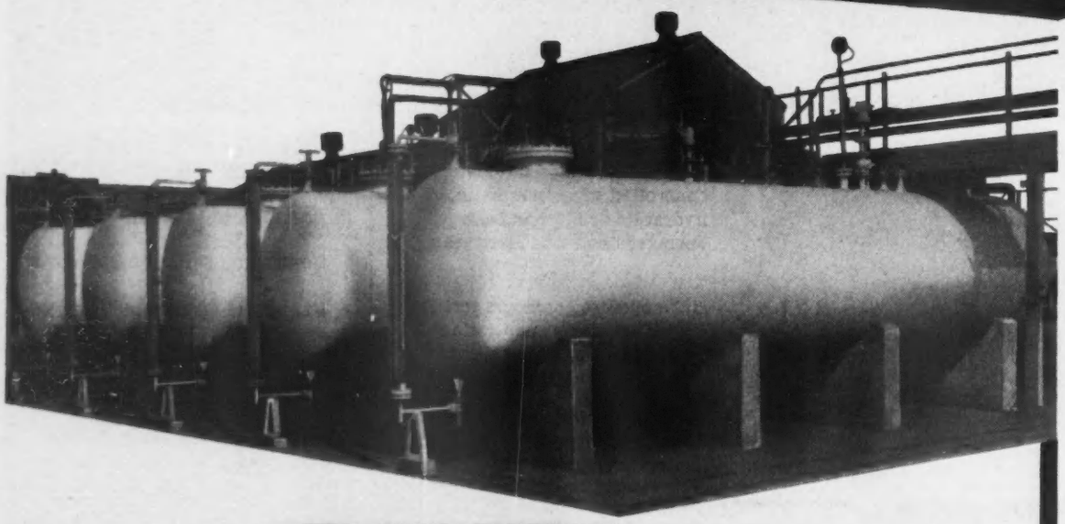

5—Horizontal Pressure Vessels. Dimensions 27′ 3½″ long × 6′ 0″ diameter. Shell ⅝″, Ends 1″ thick. Test Pressure 225 lbs. per sq. inch. A sixth vessel was supplied recently. Illustration by courtesy of National Smelting Company Ltd., Avonmouth.

We operate to the requirements of Class I and II (fusion welded pressure vessels) A.O.T.C. Rules, A.S.M.E., and similar Codes.

We produce in steel, stainless steel, and aluminium.

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WORLD'S TWO OLDEST TURBINE MAKERS COMBINE FORCES

Stockholm, Sweden—It was announced recently that the AB de Lavals Angturbin (Swedish de Laval Steam Turbine Co.), world's oldest makers of axial steam turbines, and the Svenska Turbin AB Ljungström (STAL), world's oldest makers of radial steam turbines, have merged into a new corporative unit called the de Laval Ljungström Turbine Co.

It was in 1883 that Gustaf de Laval took out his first patent for

Fredrik Ljungström

the high-speed axial steam turbine on the impulse system with expanding nozzle, flexible shaft and double helical gear. The first series of de Laval turbines for commercial use were built in 1892. Soon after the AB de Lavals Angturbin was founded with works near Stockholm.

Some 15 years later Birger Ljungström invented the radial steam turbine on the double rotation principle. His brother, Fredrik Ljungström made the practical construction of the turbine possible through his many ingenious designs. The Svenska Turbinfabriks AB Ljungström was formed in 1913 to exploit the STAL turbine.

Joint Land and Sea Operations

During the years the de Laval turbine has come to use as a prime mover for both land and marine purposes. de Laval marine propulsion units are now being built up to 28,000 s.h.p. Naval units with an output per shaft up to 45,000 s.h.p. have been built for several navies. A close technical co-operation is carried on between de Laval in Sweden and its American namesake in Trenton, N.J., together with ten licencees around the world.

Gustaf de Laval

The STAL turbine has found its place in the world's large steam power stations such as the two 150,000kW turbines at Stenungsund, Sweden, the 80,000kW plant at Odense, Denmark, and the 60,000kW turbines for Port Augusta, South Australia, and Rotterdam in the Netherlands. The STAL network of sales offices extends over 49 countries.

"L'union fait la force"

The present merger enables the two companies to pool their vast resources in research, design, construction, installation and service

Birger Ljungström

to serve the entire field of land and marine steam power, with an outstanding array of steam turbines, gas turbines and auxiliary machinery such as pumps, refrigerating machinery, etc. Address your inquiries to the de Laval Ljungstrom Turbine Company, Finspong, Sweden.

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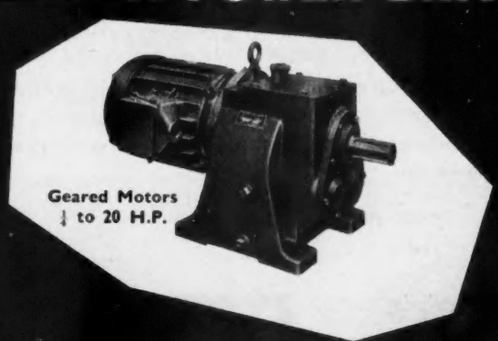

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Tecalemit Ribbon Filter Elements

Simple construction—Low cost—High flow rate—Easy to clean

The elements are formed of resin impregnated cellulose ribbon, wound helically and electrically fused into an open-ended cylinder. Innumerable microscopic orifices between the ribbons allow a very high flow rate, while retaining impurities on the outside or inside surfaces, according to direction of flow.

The standard range of diameters (in any length) covers most applications, and no other filtration material can so readily be adapted to individual requirements for filters, strainers, breathers or separators. Never before has such fine filtration been possible at such low cost and with such flexibility in use.

Tecalemit Ribbon Elements filter to maximum purity

Tecalemit Air Breather Filters

(incorporating Tecalemit Ribbon Filter Elements)

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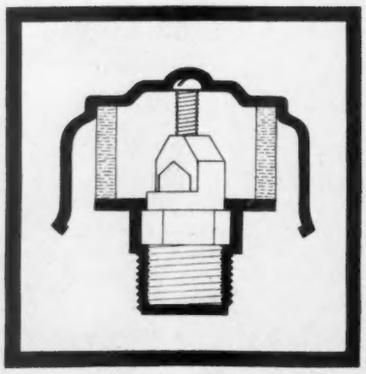
Tecalemit Breathers act as ventilators to provide a free flow of clean air to hydraulic fluid, fuel and oil reservoirs. They give positive protection from airborne contamination to tanks, pumps, valves, cylinder and other engine components. Of the standard types, two are breathers with screwed bodies, and the third is a combined clip-on assembly of breather and filter cap. All are fitted with Tecalemit Ribbon Filter Elements.

Tecalemit Breathers provide pure air cheaply and efficiently



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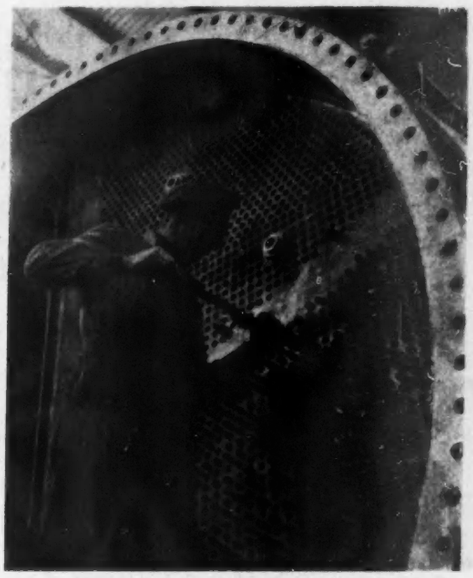
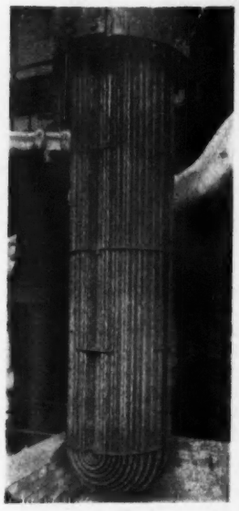
YORKSHIRE IMPERIAL

CONDENSER TUBES and PLATES

for electrical power plant



Yorkshire Imperial have supplied many millions of condenser and other tubes, and also condenser plates, for use in electricity generating stations in Great Britain and overseas, and consistently reliable, efficient and trouble-free service has been obtained from these products under a wide variety of operating conditions.



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Also tubes for air and oil coolers . . . . evaporators . . . . air ejectors . . . . drain coolers . . . . return bend heaters . . . . bus bars . . . . compressed air and hydraulic equipment, etc.

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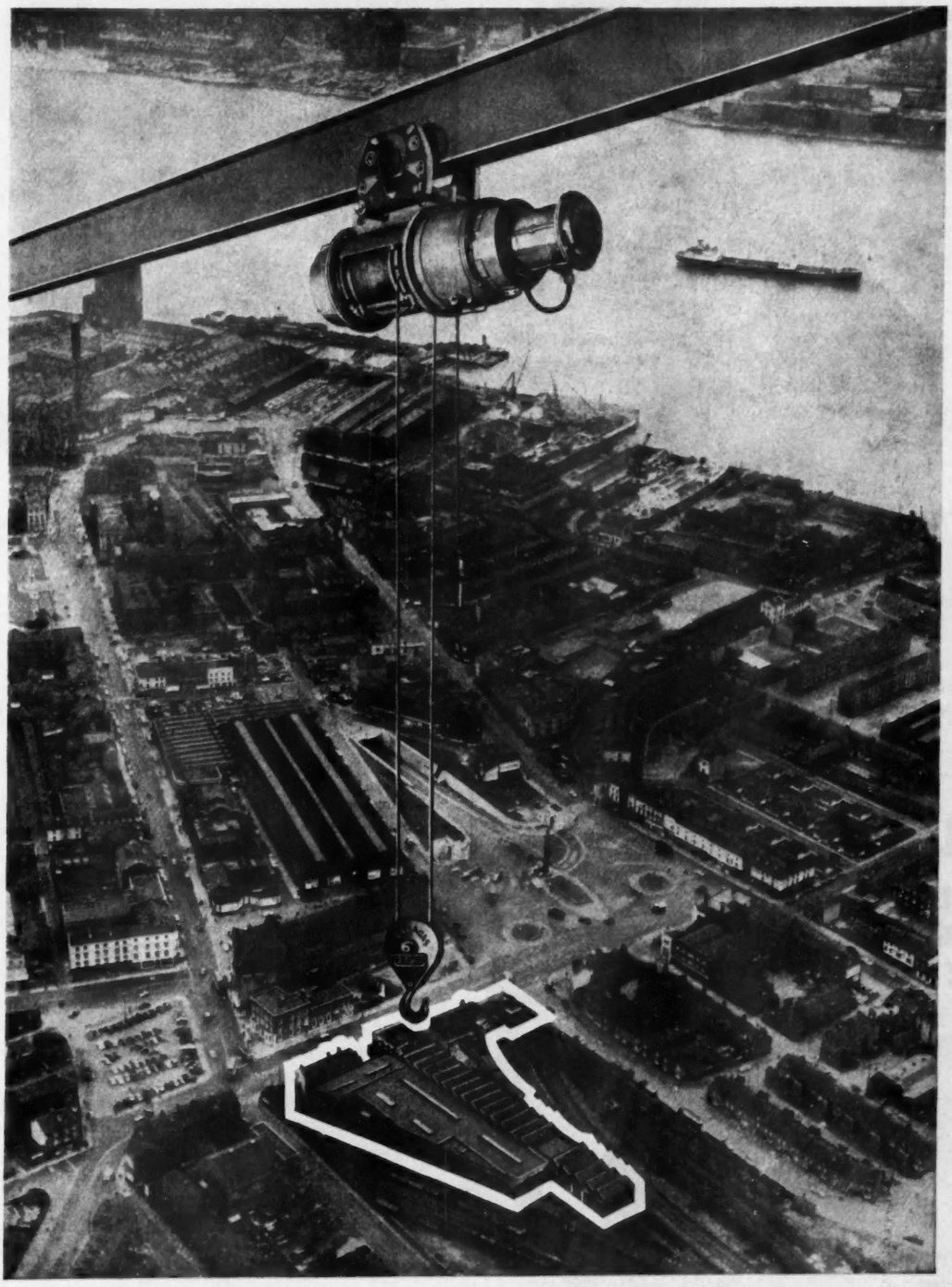

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Moreover, a few weeks later—after their client had had time to discuss the projected plans with his associates—Sykes sent over a technical representative to ensure that every aspect of the production problem had been fully understood, and all arrangements accurately planned, even down to the smallest detail.

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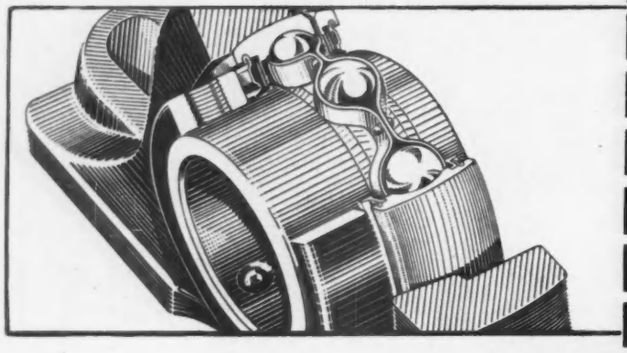

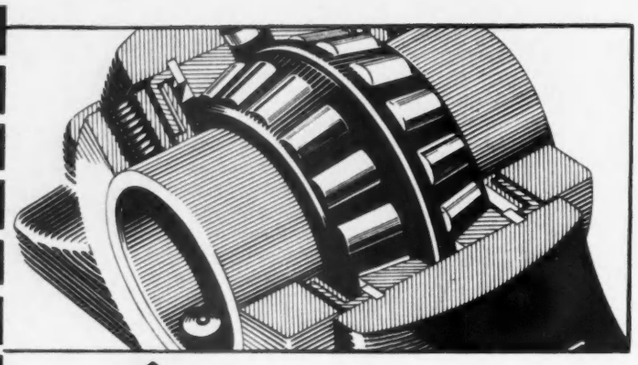

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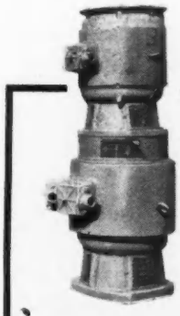

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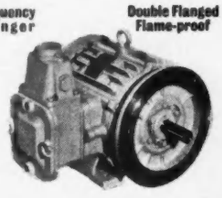

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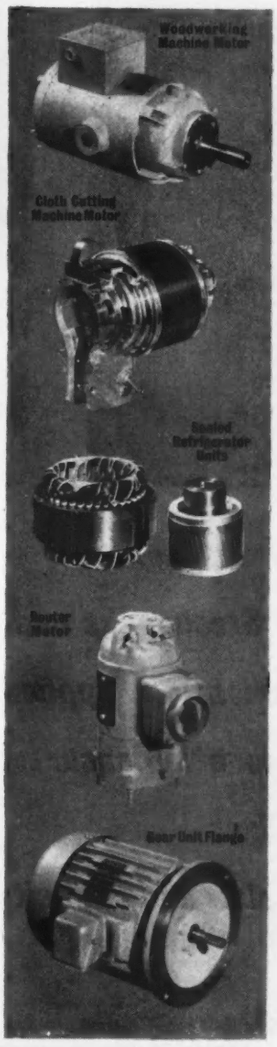

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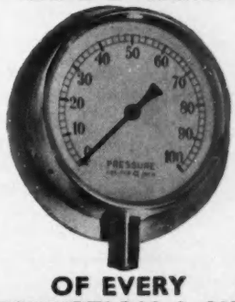

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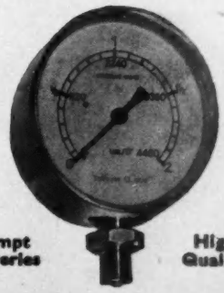

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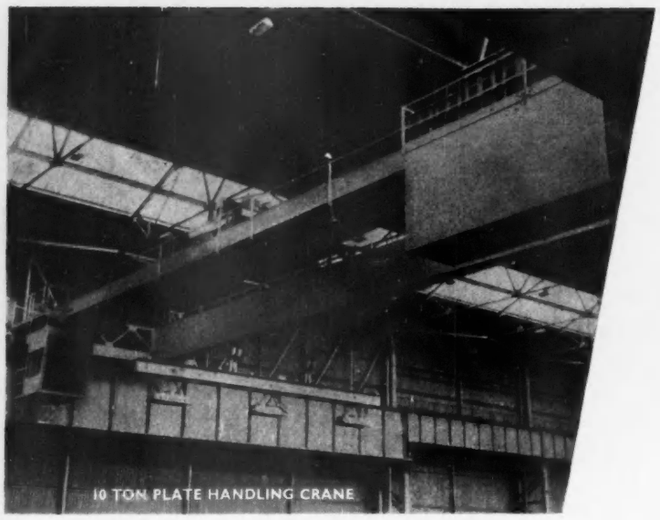
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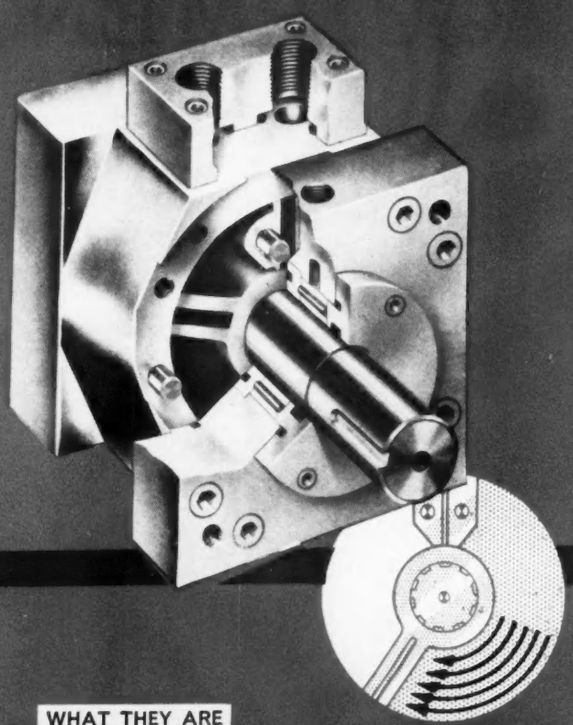
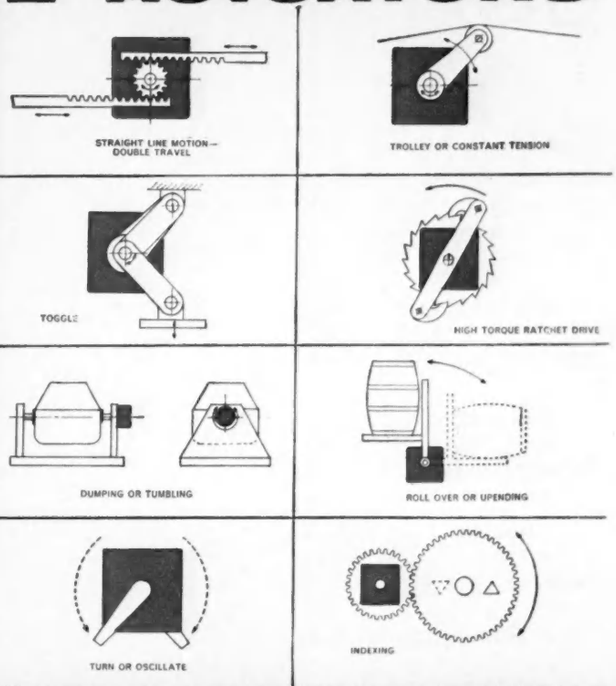
ROTARY TORQUE ACTUATORS (ROTAC)

give highest torque in least space





WHAT THEY ARE

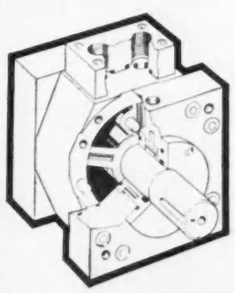
Keelavite/Rotac units are operated hydraulically at low to medium pressures, developing instant torque in either direction. For single vane units the motion is limited to a maximum arc of 280 degrees by the fixed shoe within the cylinder. Power can be doubled by the use of two vanes. In this case the arc of travel is 100 degrees.

WHY THEY ARE BETTER

Torque actuators provide high power in a small space with simple mountings. They can replace other types of actuators, such as cylinders, which require complicated linkage to perform the same functions. In hydraulic systems torque actuators are an ideal solution to many complex mechanical problems.

TYPICAL USES

Opening and closing valves.
Opening and closing doors.
Automation and machine tool uses including:
indexing, feeding, transferring, clamping, locating, turning over.
Freight car tippling.
Crane boom operation.
Pipe and tube bending.
Fatigue test applications.
Foundry equipment.
Materials handling and control of movement on conveyors.



1. *Choice of mountings for fixing at any angle in any position.*
2. *Effective sealing means no oil leak therefore positive control of shaft rotation.*
3. *Working mechanism fully sealed from dirt.*

Keelavite/Rotac rotary actuators are manufactured in the United Kingdom under licence from the XLO Corporation

THE RECOGNISED AUTHORITY

For full details write to KEELAVITE Hydraulics

KEELAVITE HYDRAULICS LTD
ALLESLEY, COVENTRY TEL: MERIDEN 441

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MEN WHO MAKE PAINT USE "BROOMWADE" PNEUMATIC EQUIPMENT

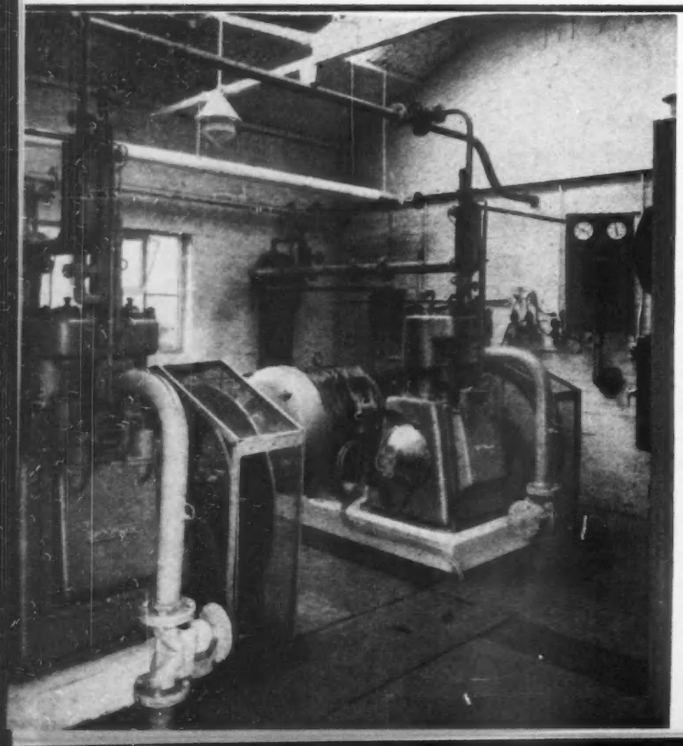
Paint manufacturers feel a sense of pride when they are told that their product is good. But for a good product, it is necessary to use the best plant.

The enviable reputation built up by "BROOMWADE" Pneumatic Equipment throughout the world is based on the proven fact that it is the BEST and MOST RELIABLE.

Behind every "BROOMWADE" product there lies 60 years' experience, backed by constant research and development and a world-wide service organisation. In addition, expert advice is available from works trained, technical representatives.

WE CAN help you with your Compressed Air Problems—

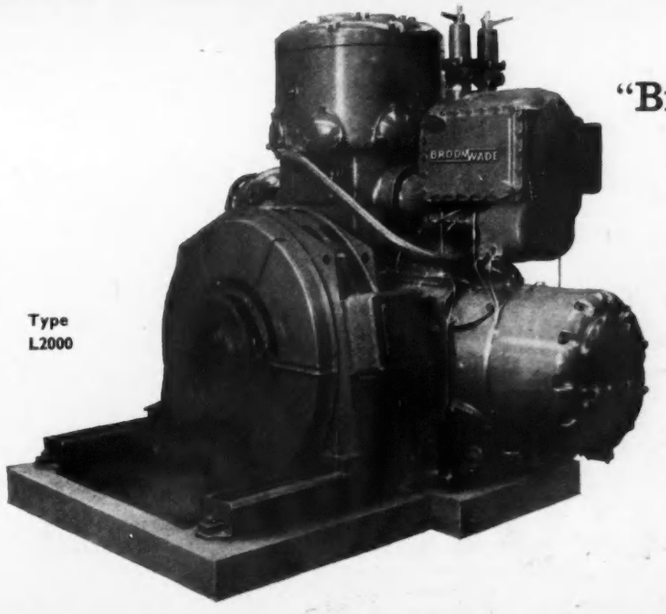
SEND THEM TO US



For instance at the I.C.I. Paint Division, Slough, where the famous "Dulux" brand paints are manufactured, two "BROOMWADE" compressors, type D23, compress inert gas, a mixture of nitrogen and carbon dioxide used in the manufacture of paints, varnishes and synthetic resins. Each compressor discharges 220 cu. ft. of "free" inert gas at pressures up to 100 p.s.i.

Other "BROOMWADE" installations supply compressed air to the Technical Service Laboratory and for general use throughout the factory.

BROOM & WADE LTD., P.O. BOX NO. 7, HIGH WYCOMBE, BUCKS.



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Type L2000 delivers 2,200 c.f.m. at 100 p.s.i.

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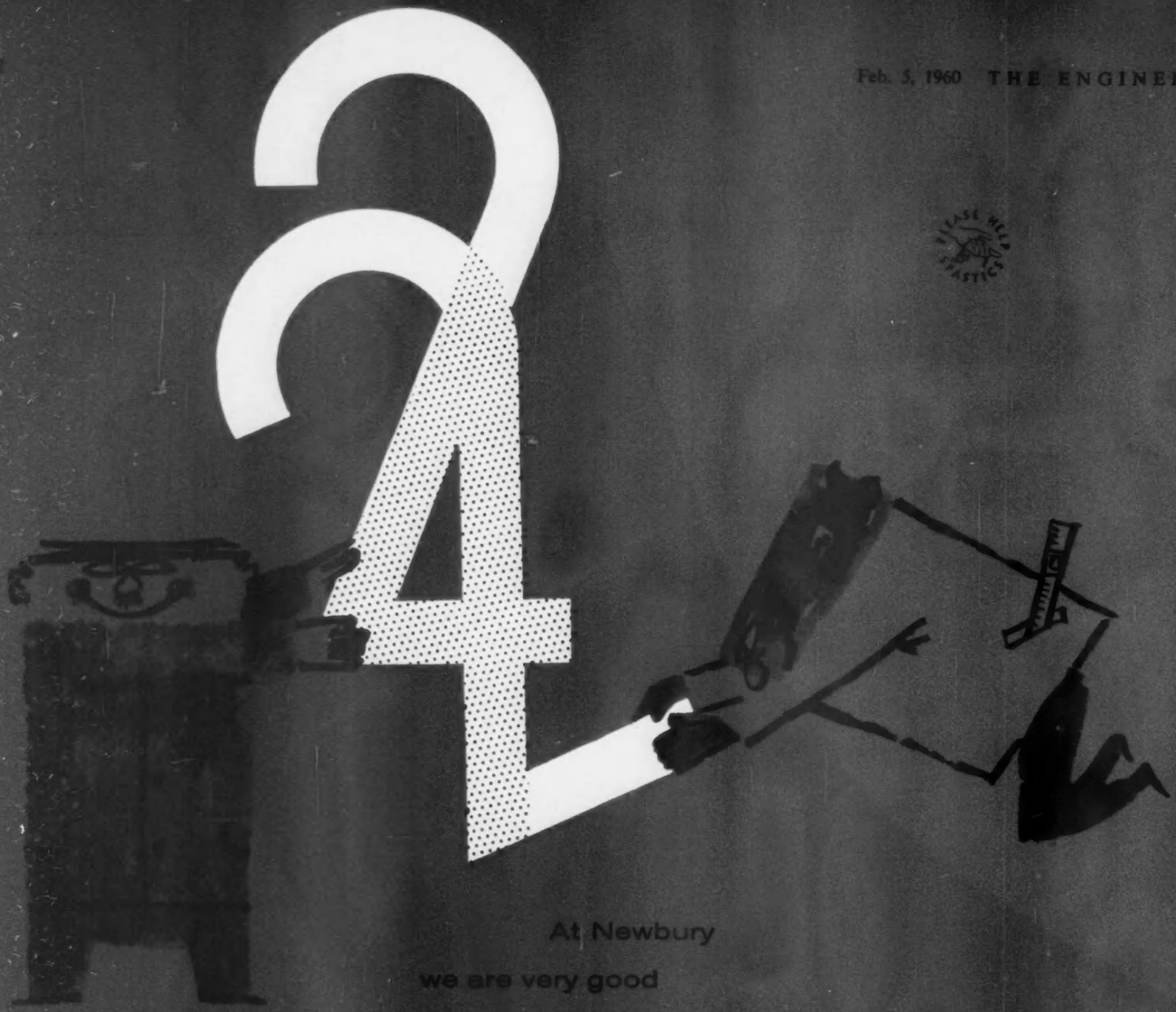

At Newbury
we are very good
at putting 2 and 2 together
and making 4 (as you can see).
That is why we welcome any kind of gearing problem.
It might be that the answer
lies in one of our standard range of units,
but if not, the experience of our
team of engineers and designers
is always at your service
to design and produce
the perfect unit for the job.

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of NEWBURY

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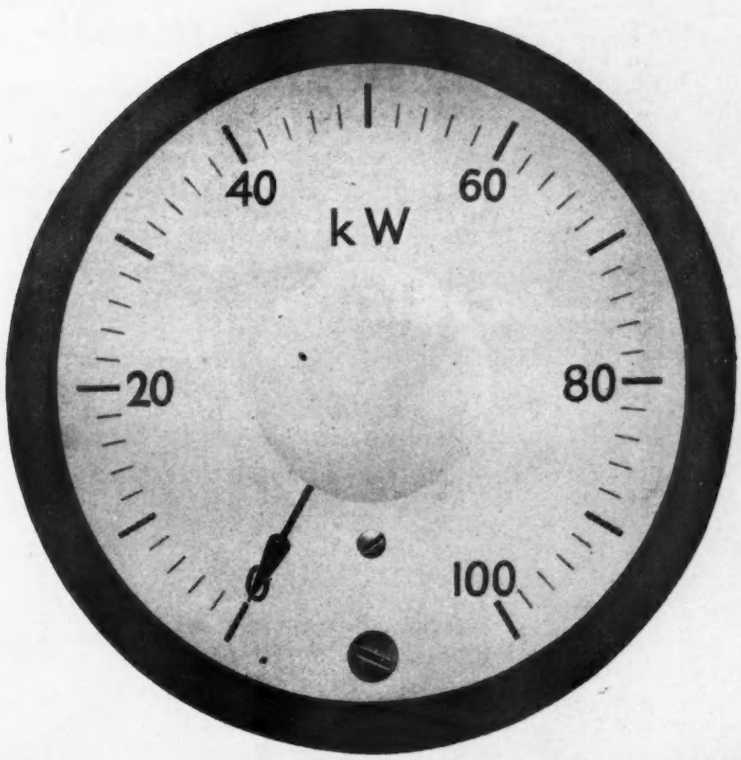


Long-range readability

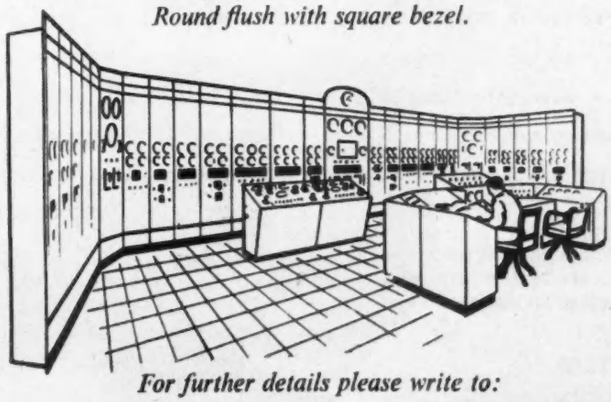
WITH

AEI instruments

With its modern scale presentation, the AEI FC2 Wattmeter can be accurately read from a distance of many feet. It is typical of a wide range of instruments from AEI, including voltmeters, ammeters, power factor indicators and synchroscopes, developed for ease and reliability of use in modern power stations.

DIAL SIZES: *4 in., 6 in., and 8 in.*

PATTERNS: *Round projecting. Round flush (as illustrated). Round flush with square bezel.*



For further details please write to:

Associated Electrical Industries Limited

INSTRUMENTATION DIVISION - Instrument & Meter Department

Trafford Park, Manchester 17

G/A705

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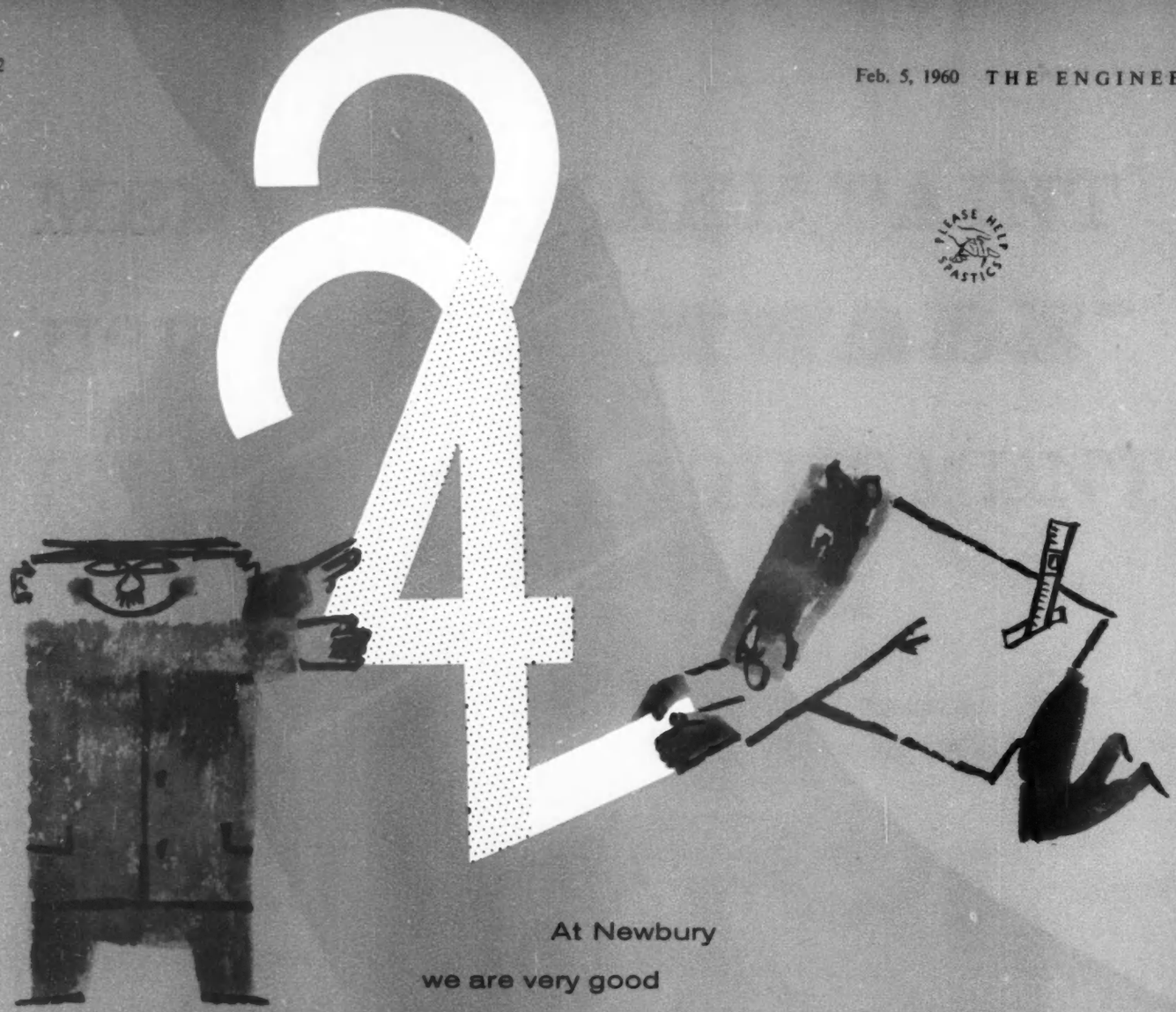

At Newbury
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is always at your service
to design and produce
the perfect unit for the job.

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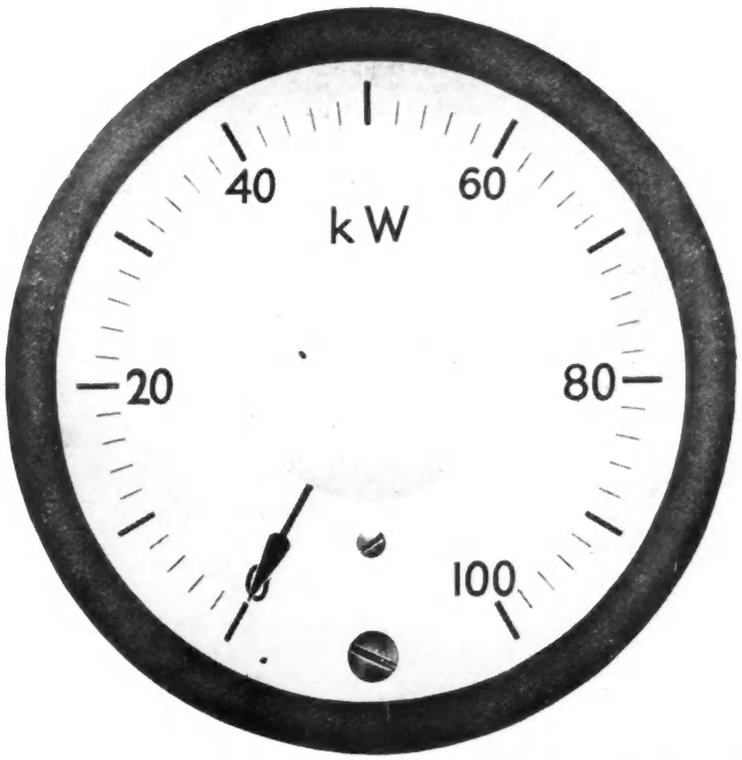

Long-range readability

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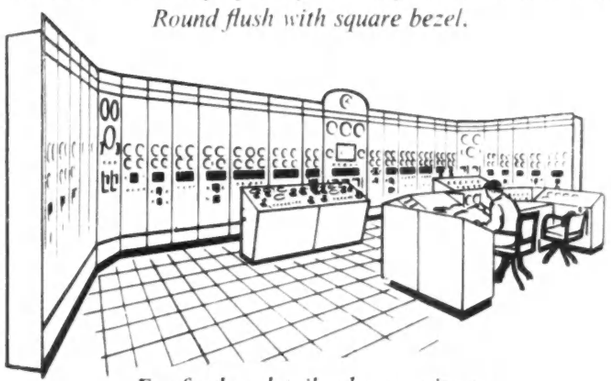
PATTERNS: *Round projecting. Round flush (as illustrated). Round flush with square bezel.*



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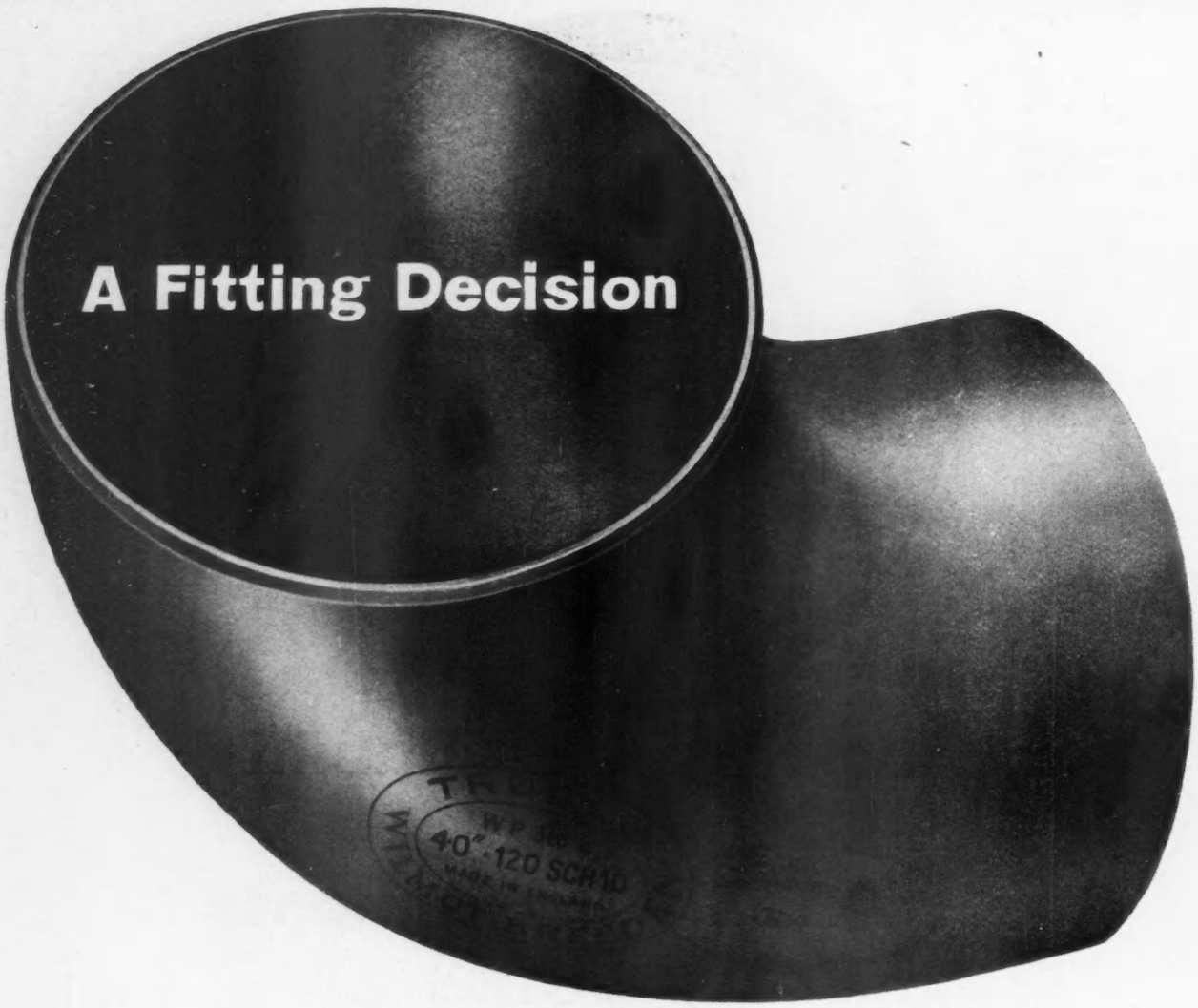


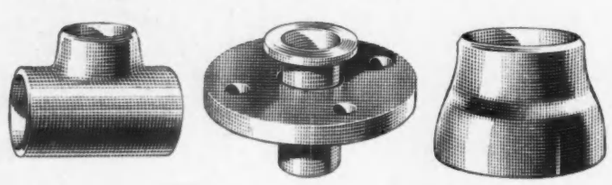
Light wall piping systems are now being specified for chemical, petro-chemical and process plants throughout the world and the demand for light wall elbows and fittings has increased accordingly.

As a result of Wilmot Breeden's recent decision to manufacture the TRUFLO range of extra low carbon stainless steel, nickel, Monel,* Inconel,* Corronel 210* and aluminium fittings in a variety of scheduled wall thicknesses, British construction engineers can, for the first time, be sure of a regular and convenient source of supply.

Many industries will have need of this service; the petroleum, chemical, nuclear and processing industries in particular, where stainless steel and nickel alloy fittings ensure the necessary safety factor.

Because TRUFLO fittings are mass-produced in the United Kingdom, their price is favourable and their availability assured.

TRUFLO fittings are manufactured to a very high quality standard of finish and conform to the dimensional requirements of American standards ASA.B36.19 and MSS.SP-43 for schedule 5s and 10s wall thicknesses and ASA.B16.9 for schedule 40s and greater. British standard BS.1640 also applies and in all cases, materials conform to ASTM.A312 and A.403 (stainless) and ASTM.B127 and B162 (nickel alloy).



* *Registered trade names of Henry Wiggin & Co. Ltd.*

TRUFLO **By WILMOT BREEDEN**

WILMOT BREEDEN Ltd., Goodman Street, Birmingham, England. *Phone: Central 8691*

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BRADFORD Steam Traps

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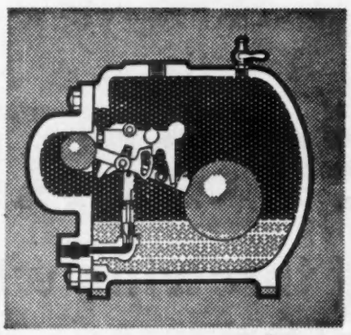
and
close



instantaneously

This instantaneous action distinguishes the Bradford Steam Trap from all its competitors. It prevents damage to valves and seats. It provides more efficient use of steam and heat, thus making an appreciable saving of fuel. Made in all sizes for all pressures. Each Trap is individually tested and fully guaranteed.

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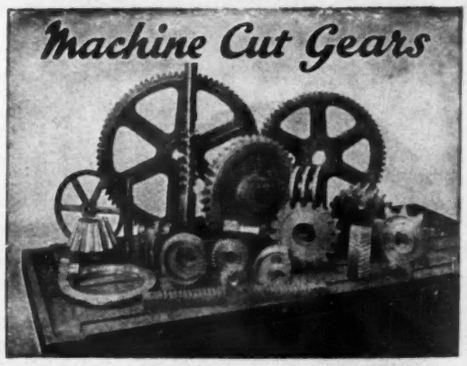

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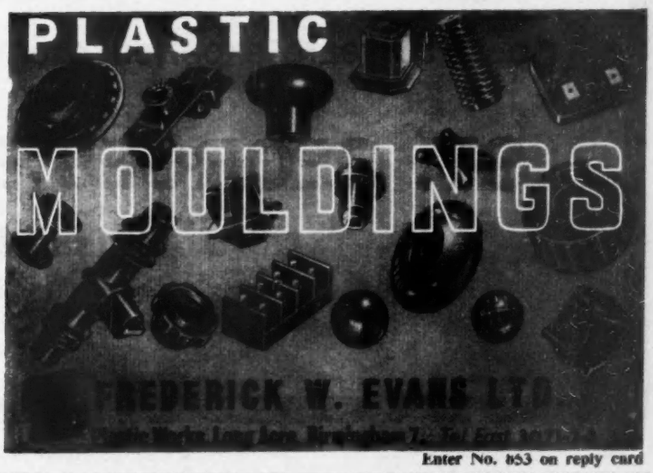

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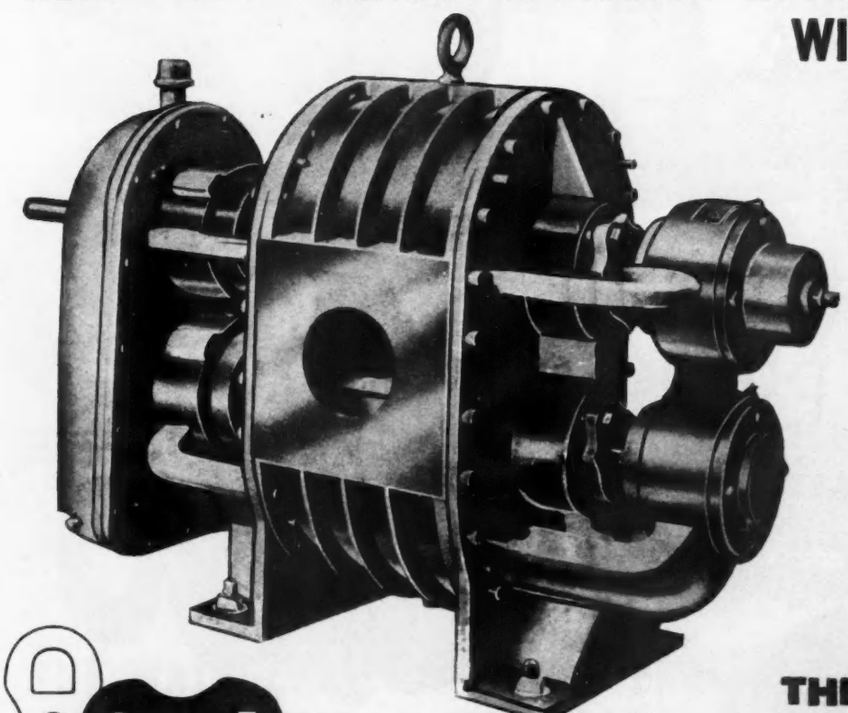
NEW "400" SERIES SUTORBILT ROTARY POSITIVE BLOWERS WITH OIL-FREE OPERATION



Because **SUTORBILT** Blowers require no internal lubrication, compressed air or gas is delivered OIL FREE. This is the most important feature in air conveyors handling food and chemicals in particular.

The new "400" Series blowers are available in 30 sizes, ranging FROM 10 c.f.m. TO 3,000 c.f.m., and pressures from ½lb. p.s.i.g. to 10lbs. p.s.i.g. (or to 15 p.s.i.g. for special application).

Constructional features of the "400" series blowers include wide face herringbone gears, thus minimising wear and maintaining close impellor tolerances.

FOR PROMPT DELIVERY AND HIGH PERFORMANCE SPECIFY **SUTORBILT** DESIGN BLOWERS —EXHAUSTERS AND GAS PUMPS.

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IS WELL BUILT

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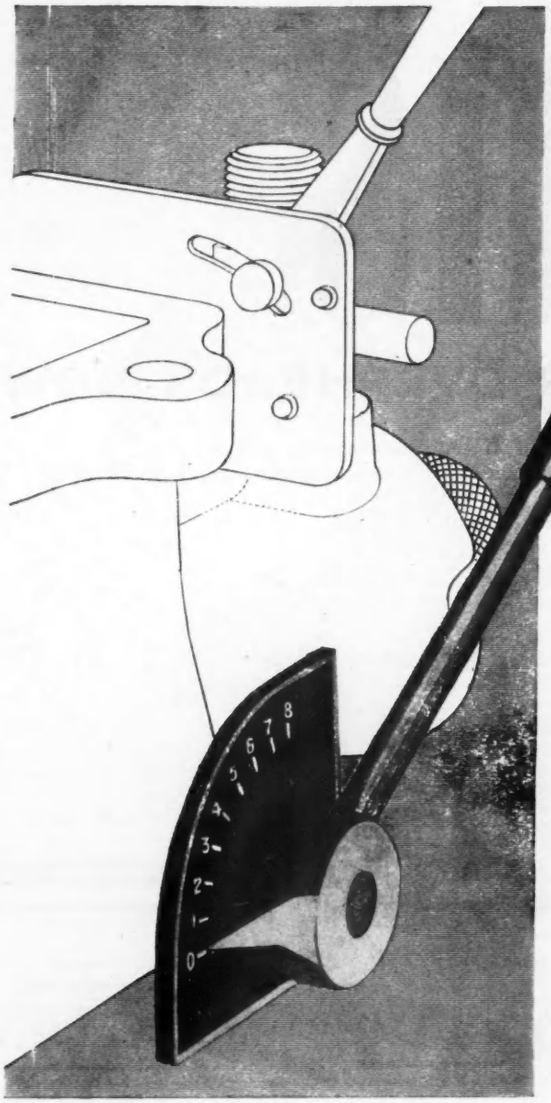

The Burner shown has a maximum output of 12 gallons per hour and requires atomising air at 20" (51 cm) w.g. to 30" (76 cm) w.g. with oil at not less than 5 lbs per sq. in. (0.35 kgs. per sq. cm.) or equivalent head.

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- . . provides fingertip, single lever control for accurate and efficient regulation.
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For more efficient

OIL BURNING

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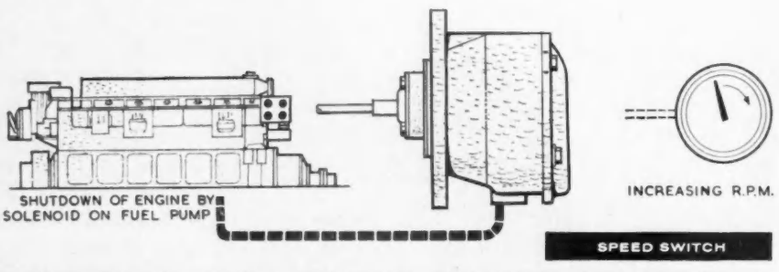

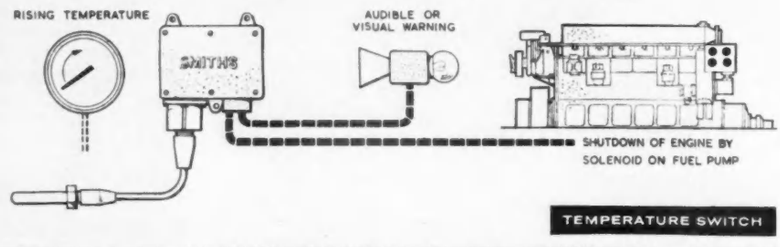

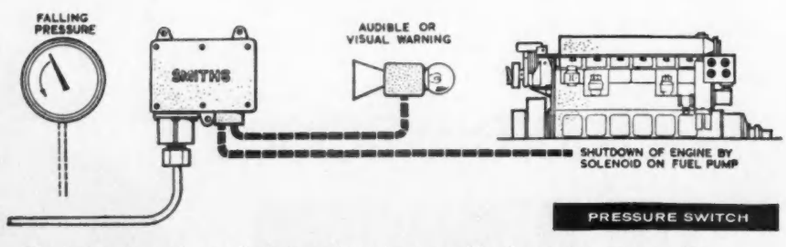

THE BASIC UNITS

These are Calibrated Relays, Speed Switches, Pressure Switches and Temperature Switches.

HOW THEY OPERATE

Instrument	'Tripping' Factor	Additional Information
Calibrated Relay	Rising or falling Voltage, Current or Speed	Usually connected to a Tachometer Generator
Speed Switch	Excessive crank-shaft speed	Combines Over-Speed Control AND starter motor isolation
Pressure Switch	Failure of Lubrication System	Embodies Warning Circuit (visual or audible signal) AND Shutdown Circuit
Temperature Switch	Failure of Cooling System	Embodies Warning Circuit (visual or audible signal) AND Shutdown Circuit

In most cases final shutdown is effected via a fuel pump solenoid, valve or fuel pump rack.

The basic units can be supplied separately, or in any combinations to meet your requirements. More important still,

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Swinging to Clayton

The picture shows one of two Clayton wall cranes specially designed for Messrs. British Thomson-Houston Ltd. for general assembly work on turbo alternators. Two overhead travelling cranes of 75 and 150 tons capacity take care of the heavy lifts.

Big manufacturers are pretty cool cats when it comes to crane buying. Habitually their standards are as exacting as their demands are imperative. Sizeable cool cats don't swing for nothing and the Clayton organisation doesn't intend to fall short of what it takes to keep 'em swinging.

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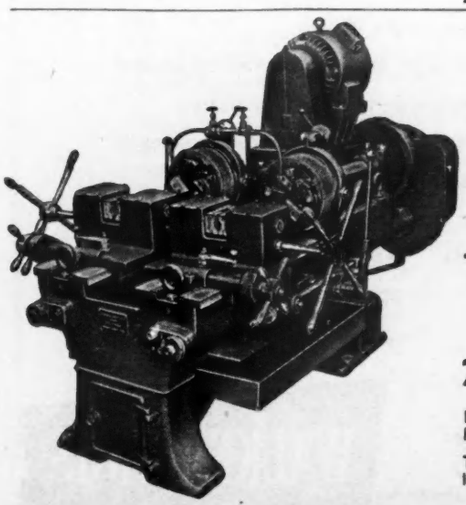

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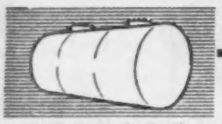

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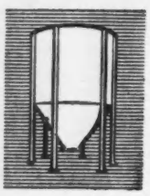

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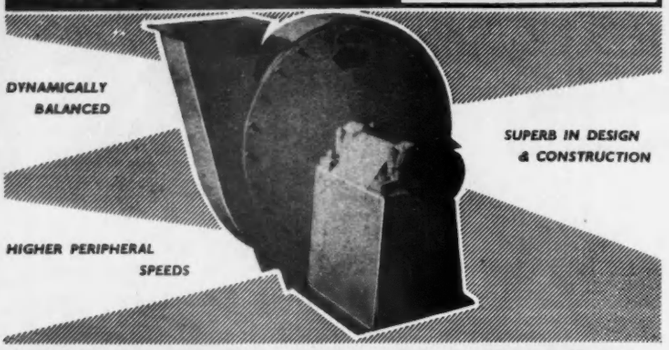
HIGH EFFICIENCY BACK BLADED FANS



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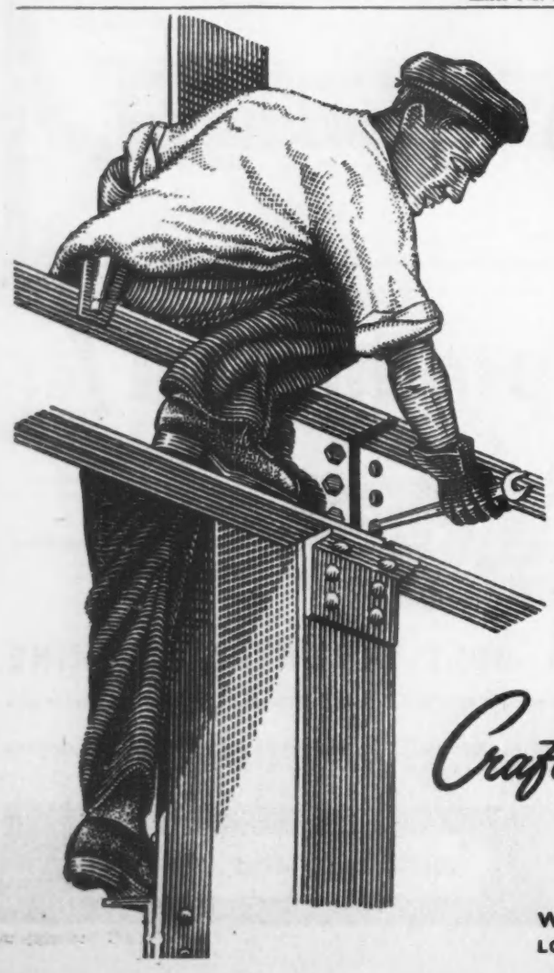

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TWO 750 c.f.m., 2-stage AIR COMPRESSORS by **Alley & MacLellan,** working pressure 100 p.s.i., speed 290 r.p.m. Arranged for "V" belt drive from 150 h.p. slipring motor by **Brook Motors Ltd.,** 400 volts, 3-phase, 50 cycles, speed 960 r.p.m., with **E.A.C.** control gear.

625 c.f.m., 2-stage AIR COMPRESSOR by **Alley & MacLellan,** working pressure 100 p.s.i., speed 290 r.p.m. Arranged for "V" belt drive from 100 h.p. slipring motor by **Brook Motors Ltd.,** 400 volts, 3-phase, 50 cycles, speed 960 r.p.m., with **E.A.C.** control gear.

TWO 600 c.f.m. single-stage AIR COMPRESSORS by **Broom & Wade,** working pressure 100 p.s.i., speed 300 r.p.m. Each arranged for "V" belt drive from 135 h.p. slipring motor by **Brook Motors Ltd.,** 400 volts, 3-phase, 50 cycles, speed 960 r.p.m., with **E.A.C.** control gear.

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TURBO-COMPRESSOR by **Adamson/Escher Wyss,** capacity 20,000 c.f.m., measured at the suction condition of 14·2 p.s.i. absolute, 65° F., discharging against pressure of 100 p.s.i.g., speed 6910 r.p.m. Compressor mounted on baseplate and direct coupled through GEAR-BOX by **David Brown** to :—

Salient pole synchronous MOTOR by **Metropolitan Vickers,** 4145 h.p., wound for 6600 volts, 3-phase, 50 cycles supply, speed 1500 r.p.m., with control gear.

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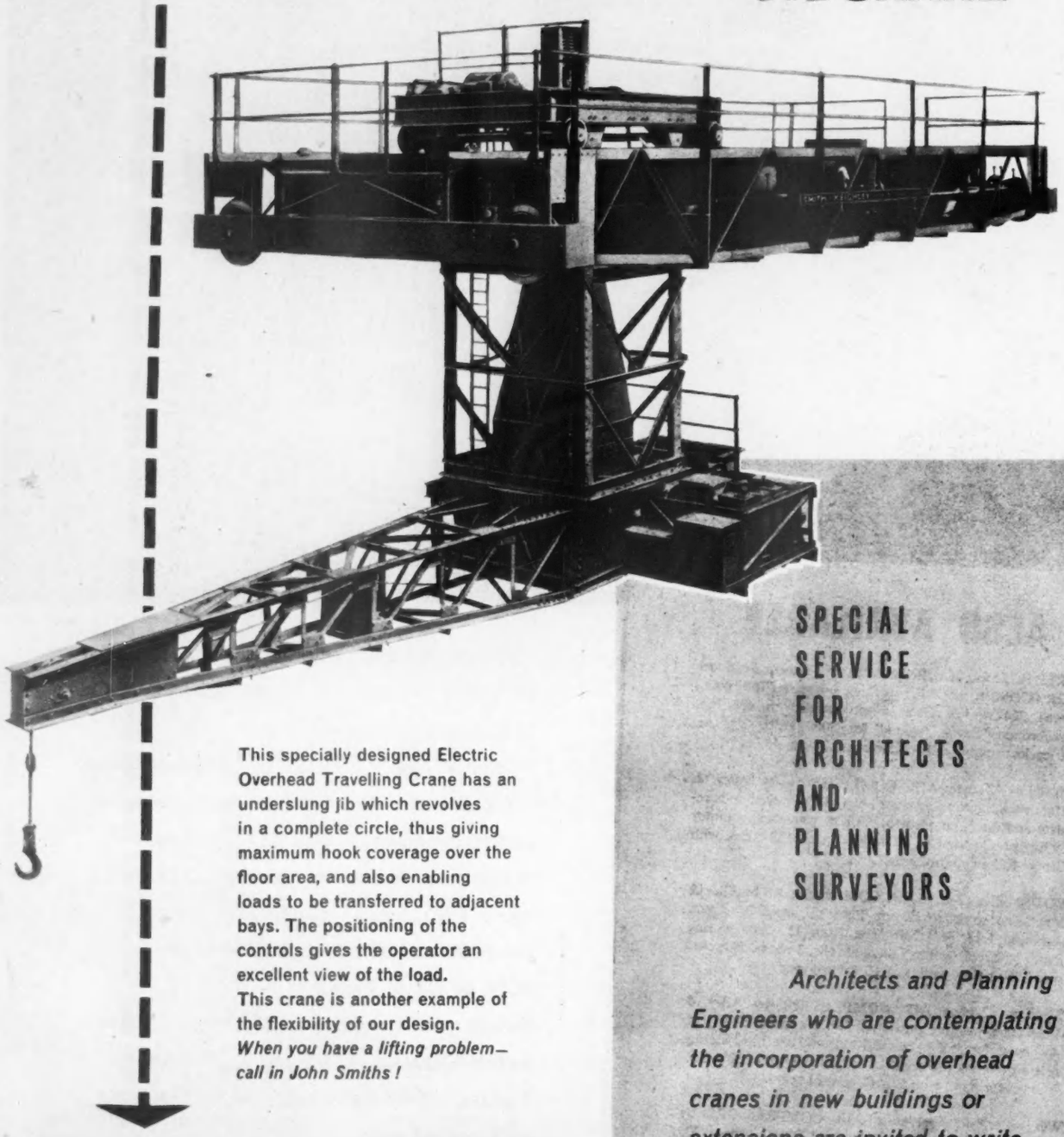
2 FULLY ROTATING JIB UNDERSLUNG CRANE



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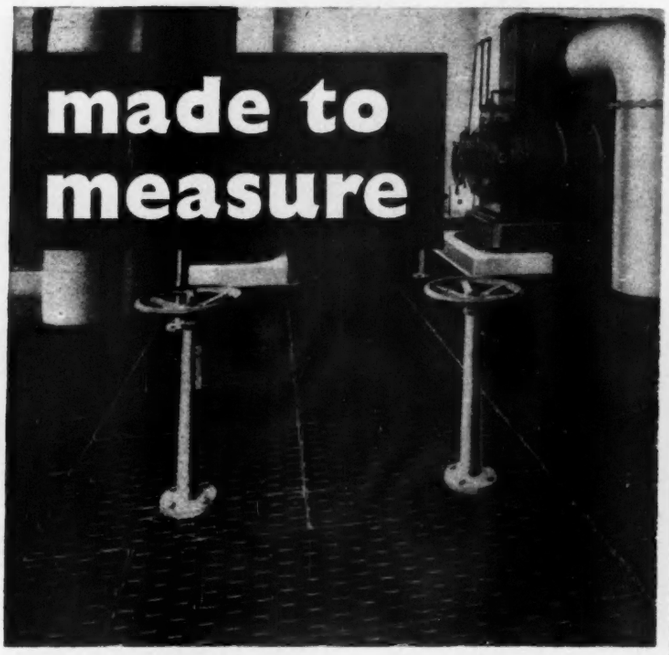

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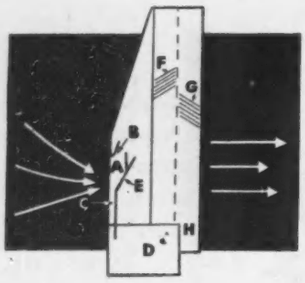

OPERATION:

Unfiltered air enters through the guard screen (A) and the major portion passes through the venturi-like passage (B). The balance of the air passes down through the passage (C) agitating the oil in the sump (D) and carrying the oil in droplet form up and into contact with the filter media (F). The oil control baffle (E) permits oil in droplet form to wash to the top of the media throughout the entire range of air demand. Eliminator media (G) provides for return of oil and contaminants to the return sump (H) where the dirt settles out and the oil returns to (D) for continuous recirculation.
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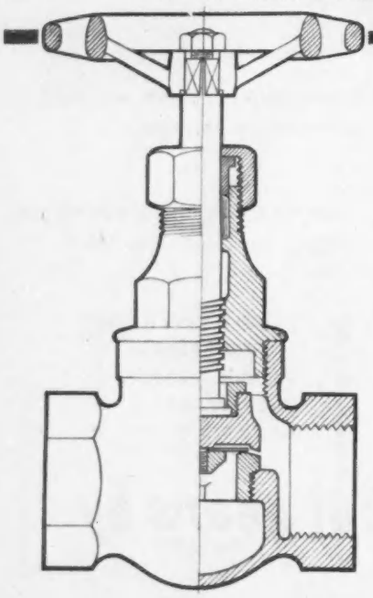
News from Hattersley



the Fig. 2016 'PRESEATOR' globe valve with the Flexible Titanium Disk*

This specially designed Hattersley valve incorporates a flexible pre-seating disk made of an I.C.I. titanium alloy which is exceptionally resistant to corrosion and erosion. As this seats before the main surfaces, pipe-scale is trapped and the main seating surfaces protected from the effects of wire drawing.

The broad-faced clack and its seat are of differing compositions of nickel alloy, giving differential surface hardness which prevents galling and seizure. There are many other fine features in this new design valve.

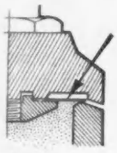
Suitable for steam at 200 lb. per sq. in. and 500° F.

Please write for literature.

* *The Flexible Titanium Disk is protected by Patent No. 822147*

Over a period of years the outstanding merits of this Valve have been proved under the most arduous service conditions on many installations.

In open position free passage for flow directed across seating surfaces.



In 'Pre-shut' position flow and pipe scale held back by *Flexible Titanium Disk.*
Patent No. 822147

Valve fully closed. Seating surfaces have passed through wire-drawing zone under virtually 'no-flow' conditions.

HATTERSLEY ESTABLISHED 1897 — **the name for good valves**

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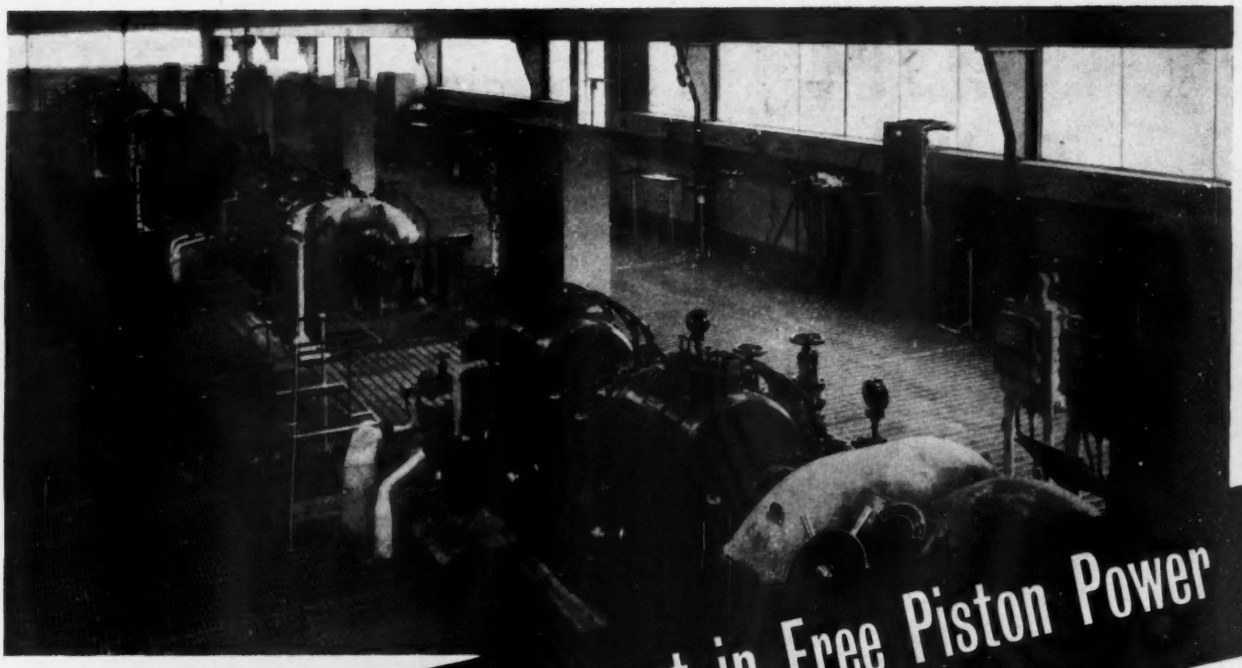

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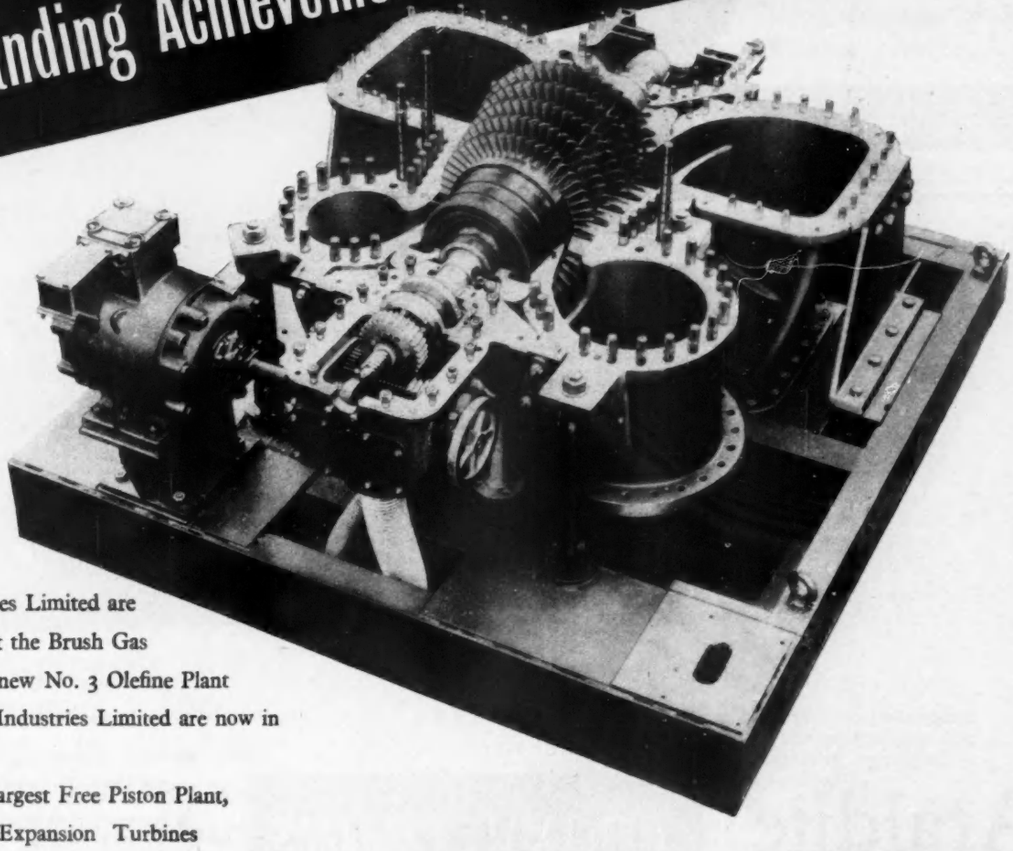

Hawker Siddeley Brush Turbines Limited are pleased to announce that the Brush Gas Expansion Turbines in the new No. 3 Olefine Plant of Imperial Chemical Industries Limited are now in operation.

This, the world's largest Free Piston Plant, incorporates six Gas Expansion Turbines totalling 16,000 h.p. and is the first application of Free Piston power to a Chemical Plant.

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Araldite epoxy resins are used

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- **for producing patterns, models, jigs and tools**
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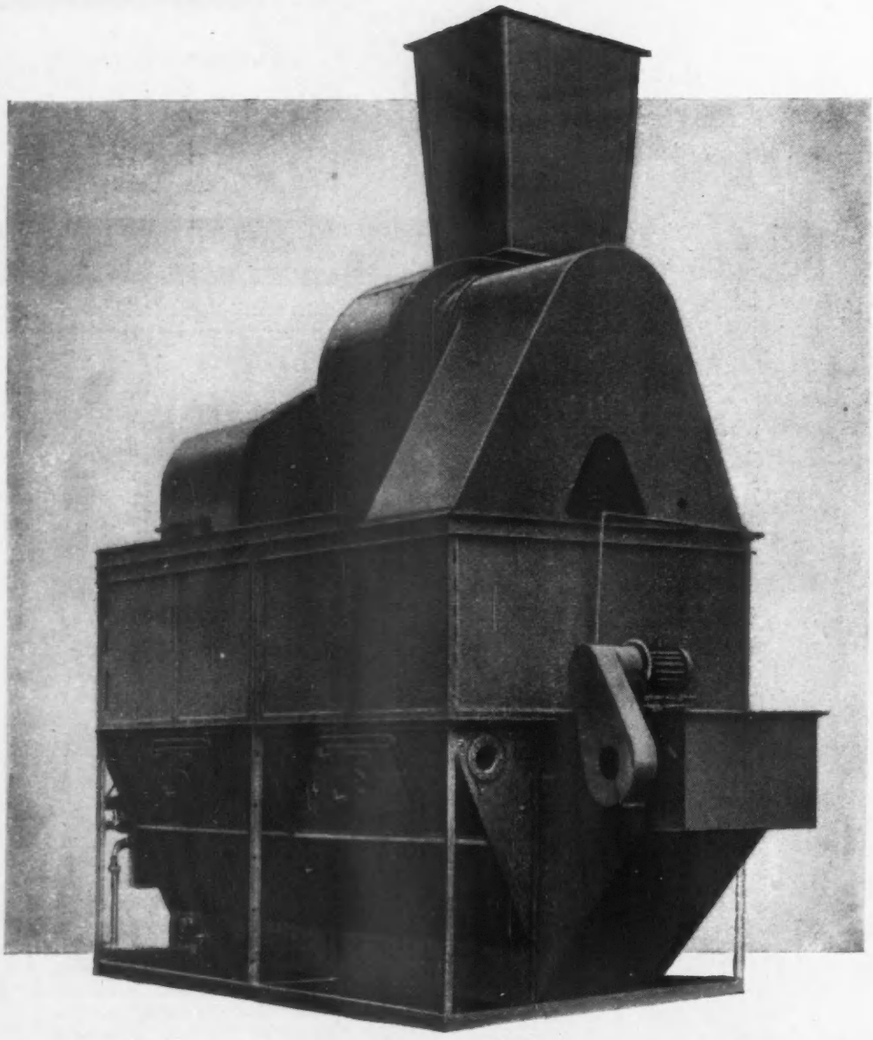

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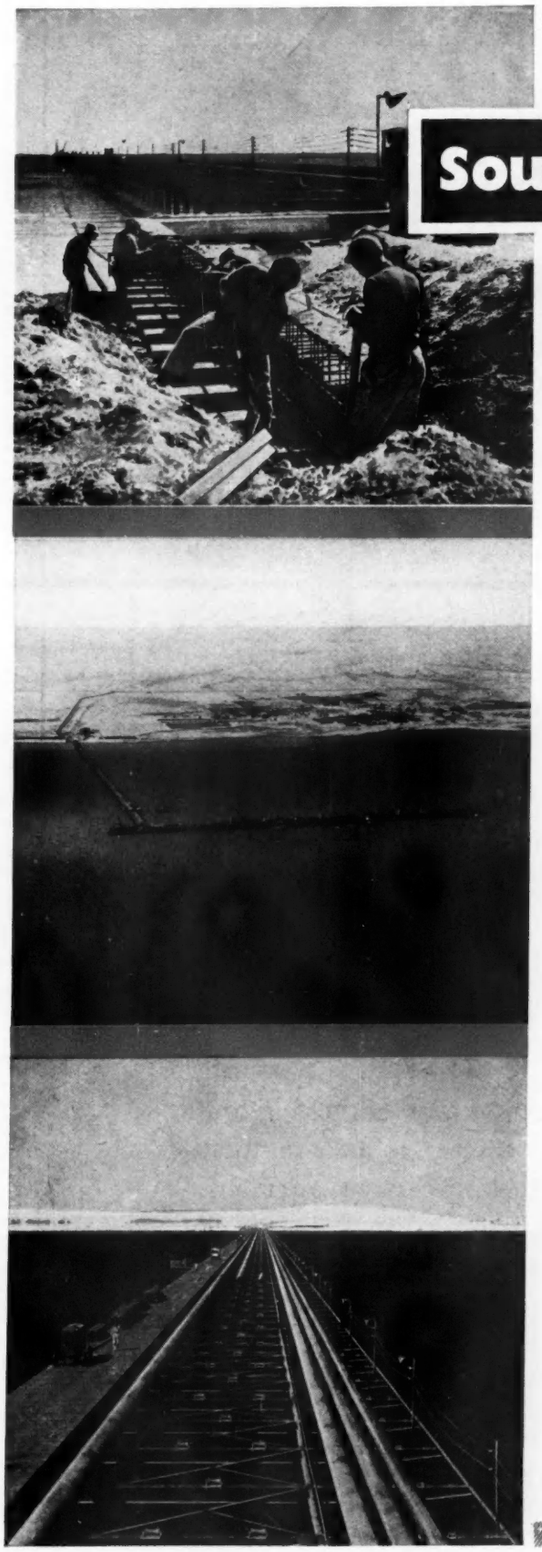

South Durham

at Mina al Ahmadi

For the construction of the Kuwait Oil Company's new North Pier at Mina al Ahmadi, Kuwait, and for extensions to its refinery, South Durham have been privileged to supply over 48,000 tons of steel made up as follows:

PIER PILES	**Tons**
"RENDHEX" FOUNDATION COLUMNS	**13,500**
PLAIN BROAD FLANGE BEAMS	**850**
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PIER DECKING	
BROAD FLANGE BEAMS (plain and plated)	**2,700**
EXTENSIONS TO REFINERY; NORTH PIER; TRANSIT AND GRAVITY LINES	
MILD STEEL PIPES from 18 inches to 40 inches diameter, automatically welded by the Submerged-Arc Process to A.P.I.5L Specification (approximately 100 miles)	**27,000**
Total tons	**48,720**

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Dust Proof

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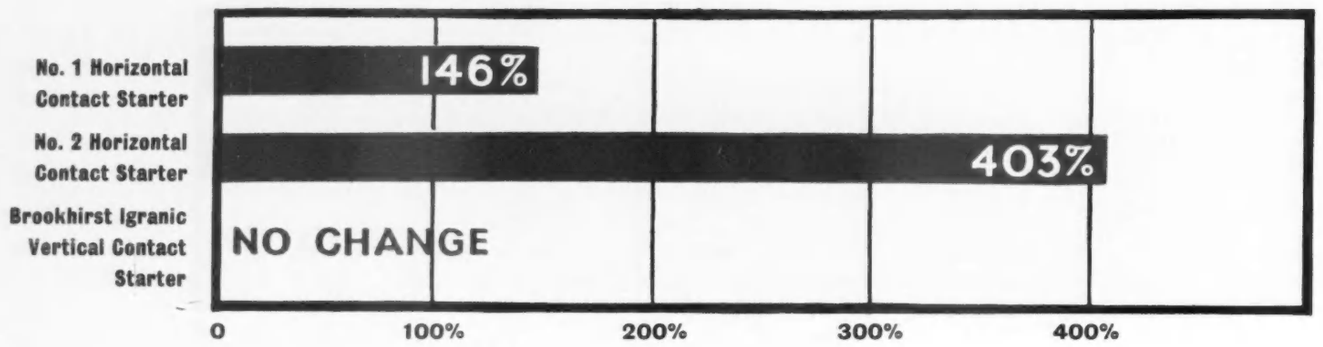

A Brookhirst Igranic motor starter with vertical contacts was tested in a standard dust chamber along with two starters with horizontal contacts.

The Brookhirst Igranic vertical contact starter alone showed no increase in contact resistance due to dust deposits, because dust cannot collect on vertical surfaces. Increased contact resistance through dust leads to heating, pitting, wear and failure.

Vertical DUST-SAFE contacts are Brookhirst Igranic standard.

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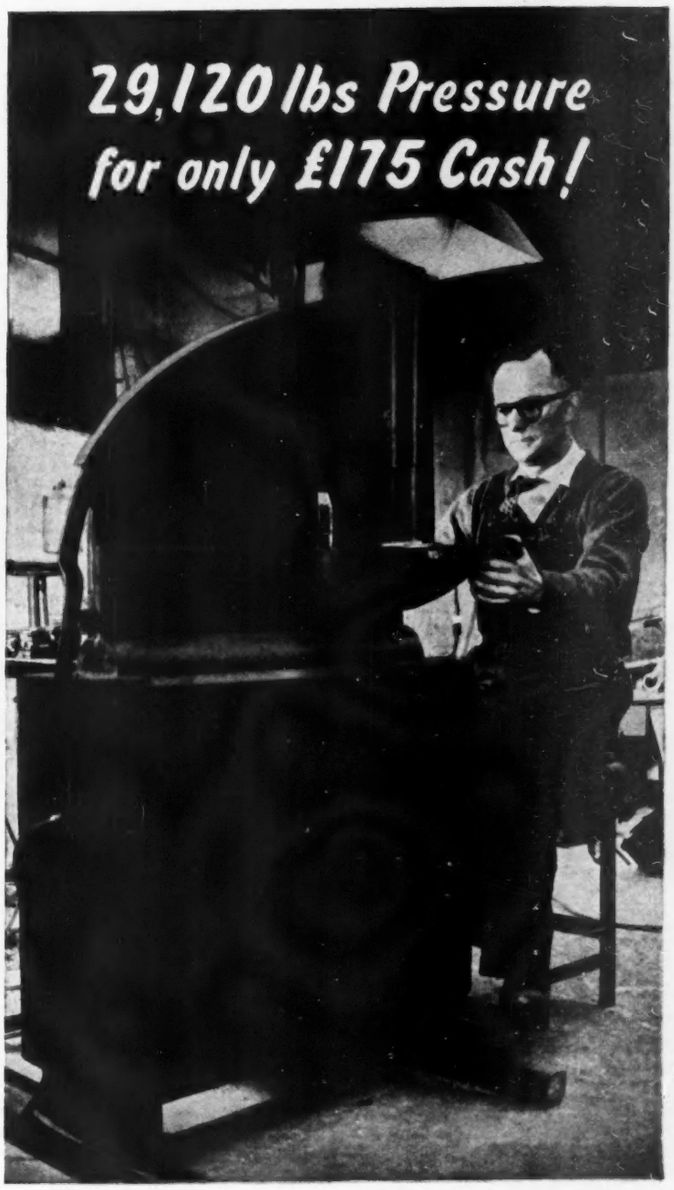

This formidable Hydraulic Cropper can cut, for instance, 2" x ½", 3" x ⅜" and 4" x ¼" thick Flat Mild Steel in one stroke and also ¼" thick Sheet and Plate to any width and all controlled by the simple pressure of the foot. It's speedy, for you can get up to 34 cuts per minute with only negligible burr. It is only 3' 0" x 1' 0" x 5' 0" high and weighs but 5 cwts.

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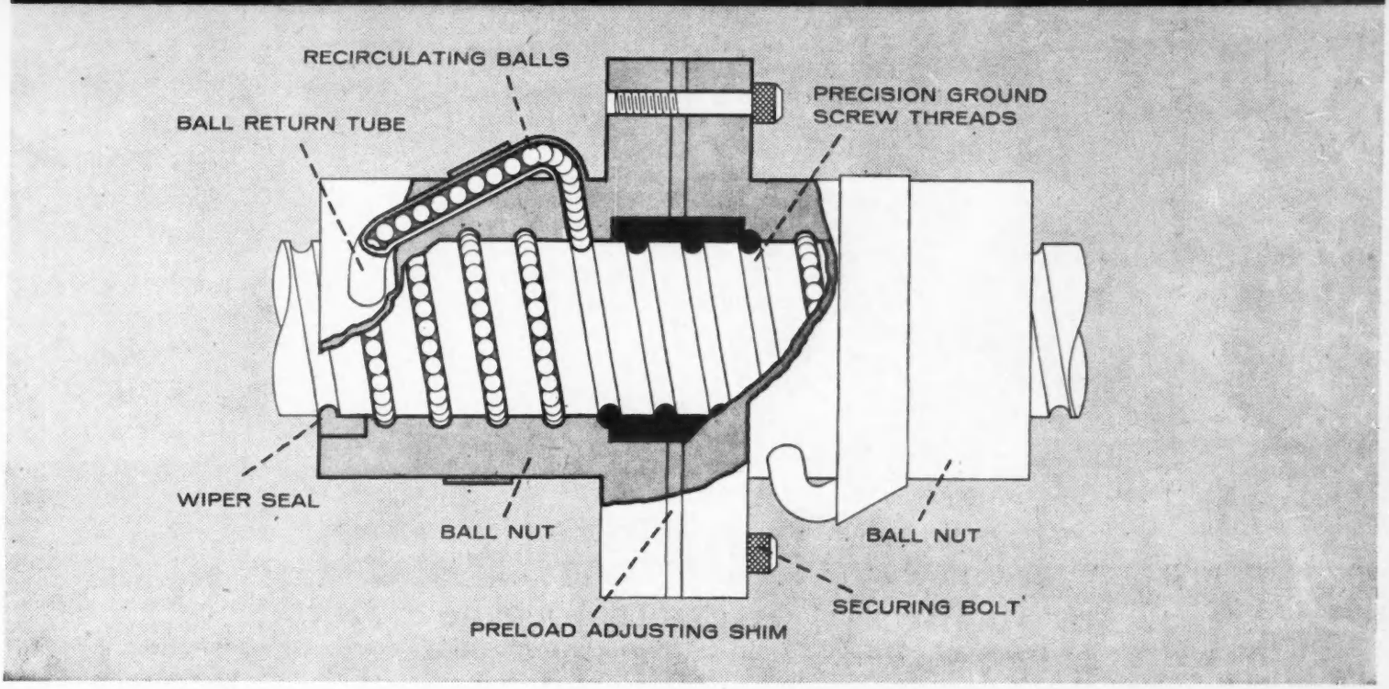

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Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of —52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:

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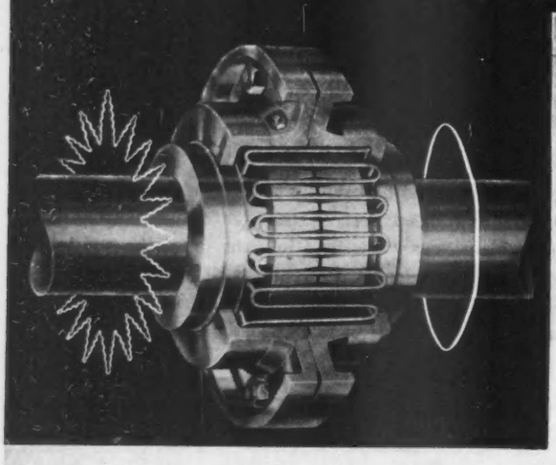
The most efficient couplings obtainable



BIBBY

Resilient

COUPLINGS

For nearly forty years Bibby Resilient Couplings have enjoyed an unexcelled reputation for efficiency and reliability and numerous Couplings supplied over thirty years ago are still giving trouble-free service.

The outstanding resilience of Bibby Couplings dampens shocks and vibrations, ensures smooth running of plant, eliminates breakdowns. Standard Couplings up to 7½" bore can be supplied from stock.

We invite you to write for our illustrated brochure.

THE WELLMAN BIBBY COMPANY LIMITED
PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1

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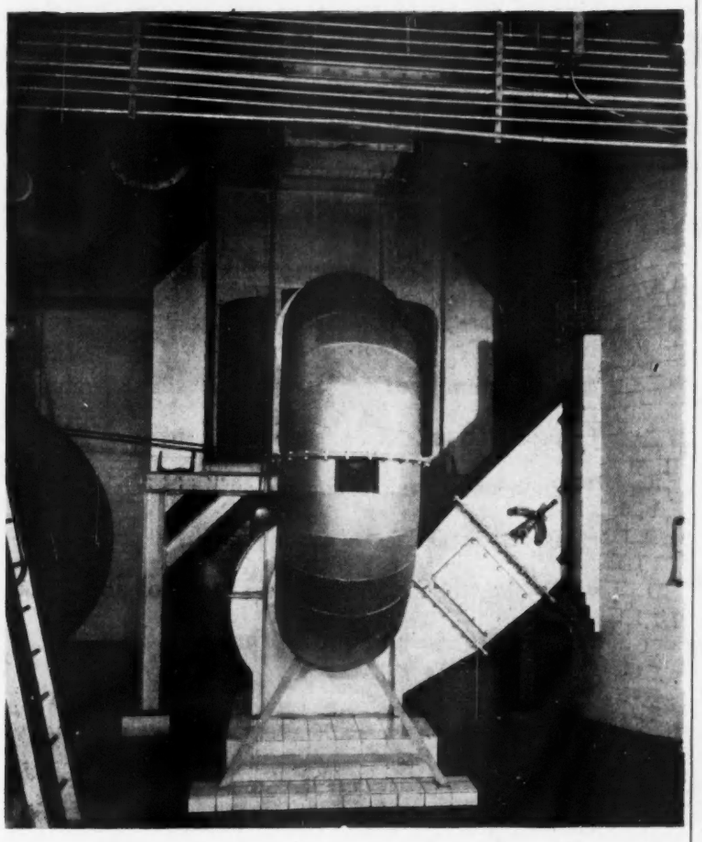

Bird's Eye Foods solve their problems of grit emission successfully and economically

with

MANCUNA DUSTEX

high efficiency miniature cyclone collectors

In most boiler installations the Mancuna Dustex Grit Arrester will provide the best possible economical solution to the problem of complying with the Clean Air Act.

In the Grimsby factory of Bird's Eye Foods, Ltd., the addition of a third boiler using induced draught created appreciable quantities of grit emitted from the chimney stack. The risk of grit settling on factory roofs and subsequent contamination of products has been eliminated. It is also interesting that plant engineers in this most moder.i factory claim that boilers can now operate at full combustion efficiency at all times.

The unit comprises exceptionally robust cast meehanite iron miniature cyclones, and has been proved the most efficient mechanical grit arrester at present available.

SPECIALISTS IN GAS CLEANING AND DUST TECHNOLOGY.

MANCUNA ENGINEERING LIMITED,
DENTON, MANCHESTER. Tel.: DENton 3965 (5 lines)
London Office: 59, Victoria Road, Surbiton, Surrey. Telephone: Elmbridge 9793.

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10 ton Steam Permanent Way Crane. Metre Gauge. Duty: 10 tons at 16 ft. radius propped; 5 tons at 14 ft. radius free

3 Motor, electrically operated Fixed Wharf Crane. Duty: 15 tons at 22 ft. radius.

T&H

CRANES

STEAM
DIESEL
DIESEL-ELECTRIC
ELECTRIC

KENT STREET
TAYLOR & HUBBARD LTD
LEICESTER

Telegraphic Address: "Lifting, Leicester"

Telephone Nos.: 22579-6

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KINNEAR SHUTTERS

by the makers of Kinylon and Kinrod Grilles

solve the problem

of wide entrances and a sloping road. The bottom rails on these Kinnear Shutters are shaped to accommodate the rise of the road, to ensure good closure and complete weather protection.

Please send for illustrated leaflet 7B

ARTHUR L. GIBSON & CO. LTD., TWICKENHAM, MIDDLESEX.

Telephone: Popesgrove 2276. *Birmingham:* Highbury 2804. *Glasgow:* Halfway 2928. *Manchester:* Central 1008. *Cardiff* 51428

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LONG RIGIDAL

saves time and money

Rigidal corrugated aluminium roofing and siding sheets, available in standard lengths up to 35 ft, save or even eliminate end laps, cutting material costs and improving weather-tightness. Handling time and labour costs are also considerably reduced.

At the Carsebridge Distillery of the Distillers Company Limited, 260 tons of 28 ft 9 in. long sheets of Rigidal 3″ Pitch were used to cover over 1,000,000 sq. ft of roofs of the D.C.L. new, one-million-pound Scotch whisky warehouse. A further 40 tons of aluminium were used for flashings, ventilators, etc.

Main contractors:	Bone, Connell & Baxters Ltd Redpath, Brown & Co Ltd
Roofing & Siding contractors:	Maintenance (Edinburgh) Ltd

The BRITISH ALUMINIUM Co Ltd

NORFOLK HOUSE ST JAMES'S SQUARE LONDON SW1

AP360

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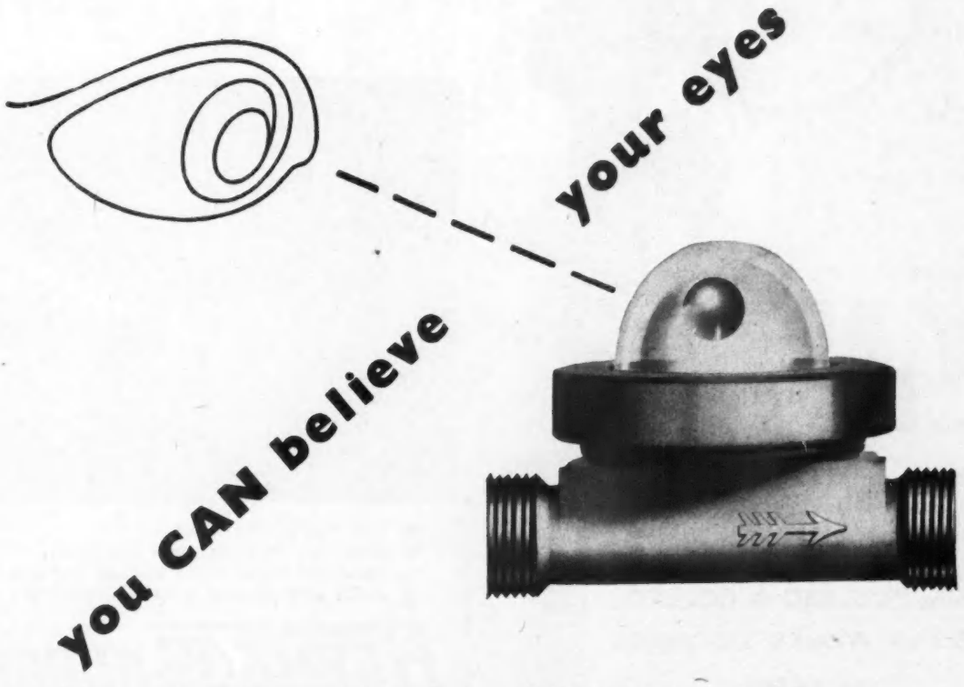
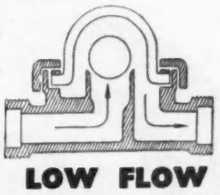


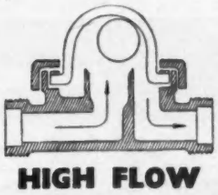
You don't need second sight when a 'SHOFLO' is in the line.

Where circulating water systems are concerned, for radiators, condensers, liquid vats, oil coolers, radio transmitting equipment and the like, a 'SHOFLO' Indicator is the perfect answer when you've got to tell *at first sight* whether the coolant is flowing or not.



LOW FLOW

A whirling ball under the toughened glass dome indicates passage of clear or translucent liquids at flows as low as 4 g.p.h., pressures up to 100 p.s.i. Standard casing is aluminium bronze for ½" sizes, gunmetal for 1½" sizes; other metals for alkaline or acidic fluids.



HIGH FLOW

Available in two sizes: Nominal ½" and 1½" bores for flows up to 2,000 g.p.h. ½" size also made with right angle inlet and outlet.

SHOFLO
tells at a glance

MEASUREMENT LTD., Tameside Works, Dobcross, Near Oldham. Tel.: Delph 424 (5 lines)
EXPORT ENQUIRIES to: Parkinson Cowan Group Exports Ltd.,
Terminal House, Grosvenor Gardens, London, S.W.1.
Telephone: SLOANE 0111/4 Cables: DISC, London
A Parkinson Cowan Company

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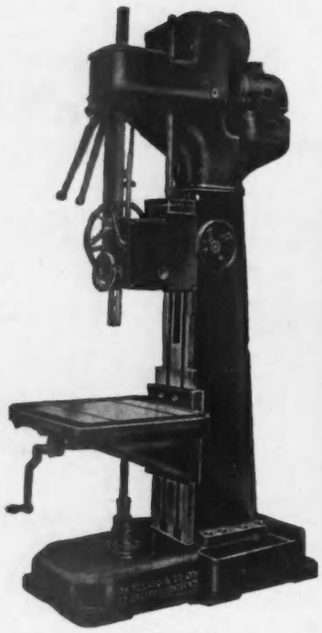
N

CORONA

GENERAL PURPOSE
UPRIGHT DRILLING MACHINES



THREE SIZES
21"—25"—28" Swing
1¼"—1½"—2" Drill Capacity

Box Column and Round Column Models in each size

Nine Spindle Speeds
Variable Automatic Feed

Box Column Models supplied in Gang Drill Form

Telephone *Leicester 67534 (5 lines)*

FREDK. POLLARD & CO. LTD.,
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ENGLAND

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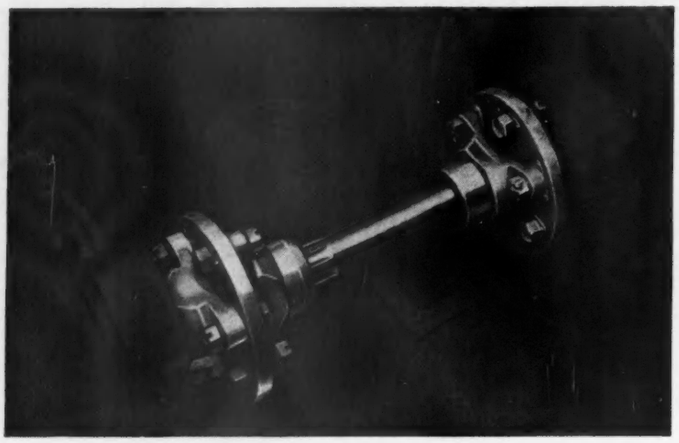
POWER TRANSMISSION—
through the medium of
FLEXIBLE FABRIC COUPLING DISCS



★ Are easily assembled.
★ Give extreme torsional flexibility.
★ Absorb irregularities in load variations.
★ Axial and parallel misalignments are corrected.

ESTABLISHED 1895
HERMETIC RUBBER Co LTD
Hermetic Works, Ryland Street, BIRMINGHAM, 16
'Phone: EDGbaston 0183/4 Telegrams: "Hermetic Birmingham."

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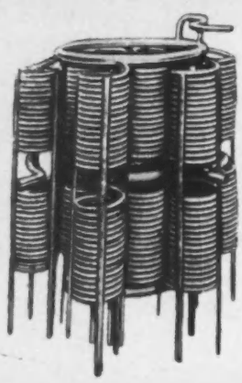
ENGINEERS!
buy from
KIRKS-

FORGED STEEL & STAINLESS STEEL FLANGES

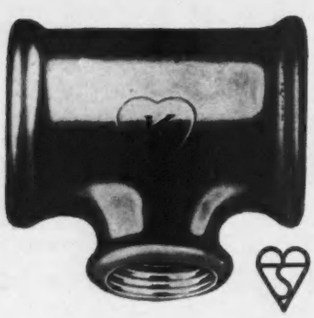
TO BRITISH & AMERICAN STANDARDS

WELDING FITTINGS

FABRICATED PIPEWORK IN STEEL STAINLESS STEEL AND COPPER



THE HEART OF RELIABILITY



MALLEABLE TUBE FITTINGS TO BRITISH STANDARD 1256

...and you **BUY BRITISH!**

KIRK

& CO (TUBES) LTD

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BERMONDSEY 3156 7 8
WALSALL MANCHESTER PONTYCLUN

—as British as the Flag

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TUFNOL

MACHINES EASILY

Here is a tough and hardwearing material, only half the weight of Aluminium, that can be machined easily with the usual engineering tools. It may be turned, milled, filed, drilled, routed, screwed and tapped, sawn or punched to make components of almost any shape. No wonder Tufnol is used extensively for engineering components. It's so adaptable.

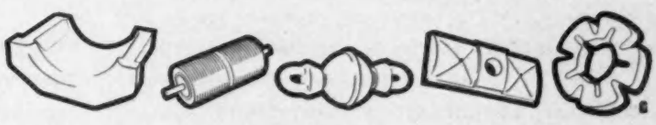
Ask our Engineer to come and talk Tufnol with you.

STRONG BUT LIGHT
RESISTS CORROSION
WITHSTANDS CLIMATIC EXTREMES
GOOD ELECTRICAL INSULATOR
MACHINES EASILY
CAN BE STORED INDEFINITELY

TUFNOL

(Regd. Trade Mark)

Available in sheets, tubes, rods, angles, bars, channels and in several brands



TUFNOL LTD · PERRY BARR · BIRMINGHAM 22B

383

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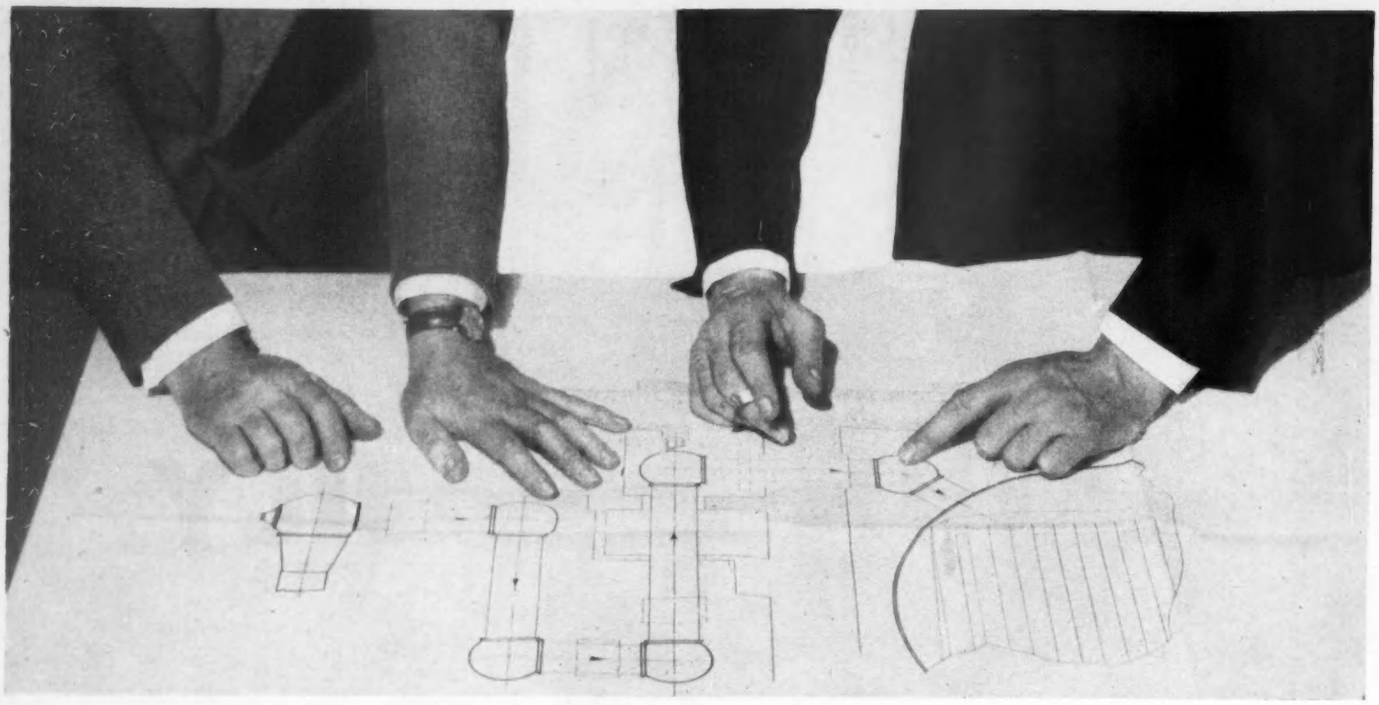
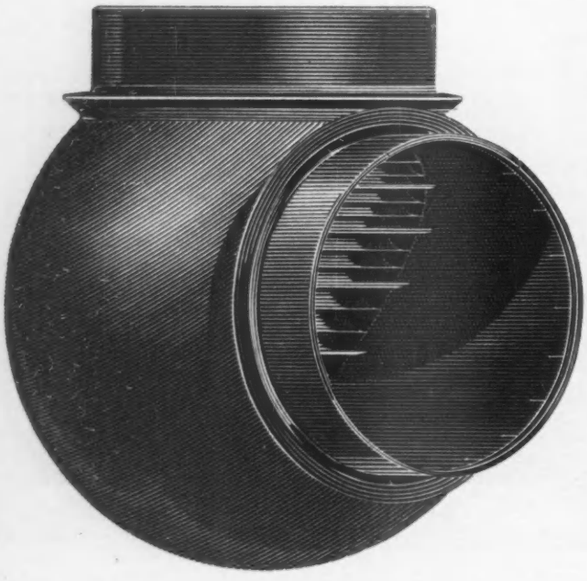


YOU COULD HEAR A PENNY DROP . . .



We spread out the drawings . . . an instant of surprised silence; then that gratifying sound. It is usually something like "Of course! Why didn't somebody think of that before."

Why not indeed? All we have done is to make the bends in the CO_2 pipework of an atomic reactor, spherical. Any schoolboy with G.C.E. physics knows the formula for the thickness of a pressure vessel—

Cylindrical: $t = \frac{P.R.}{S}$ Spherical: $t = \frac{1}{2}\frac{P.R.}{S}$

So with a sphere you can halve the thickness of the plate. But that is only the beginning. Bonuses roll in. All welds become circular, can be made by machine and can be X-rayed easily and completely. There are no uncertainties—no stiffening webs, for instance, attached by welds which cannot be X-rayed. The guide vanes are part of a lightweight duct, inside the sphere and thus unstressed by pressure.

A simple and indeed an obvious idea; but it can save large sums of money on the cost of a power station or a wind tunnel. The fact is it is not easy to see the obvious; the orthodox approach, the standard answer, get in the way. However, some of our engineers seem to be able to do it, thank goodness.

RICHARDSONS, WESTGARTH & CO. LTD.

Wallsend, Northumberland and at 58 Victoria Street, London, S.W.1.

The controlling Company of the RICHARDSONS WESTGARTH GROUP, co-ordinating the activities of:—

THE NORTH EASTERN MARINE ENGINEERING CO. LTD.
PARSONS MARINE TURBINE CO. LTD.
GEORGE CLARK & NORTH EASTERN MARINE (SUNDERLAND) LTD.
RICHARDSONS WESTGARTH (HARTLEPOOL) LTD.
THE HUMBER GRAVING DOCK & ENGINEERING CO. LTD.
RICHARSDONS WESTGARTH ATOMIC LTD.
RICHARDSONS WESTGARTH, INC.

ASSOCIATED COMPANY: ATOMIC POWER CONSTRUCTIONS LTD.

RWG

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £103.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-. **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to :—*Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

FOURAH BAY COLLEGE

UNIVERSITY COLLEGE OF SIERRA LEONE

LECTURERS

Applications are invited for (A) SENIOR LECTURER to be Head of Department of Engineering, and (B) LECTURER IN ENGINEERING. Salary scales : (A) £1700 by £75 to £2150 p.a., plus Head of Department allowance £150 p.a. (B) £965 by £50 to £1415 ; £1490 by £75 to £1790 p.a., entry point according to qualifications and experience. F.S.S.U. Outfit and family allowances (maximum £300). Passages on appointment, annual leave and normal termination. Part-furnished accommodation at reasonable rent.

Detailed applications (6 copies) naming 3 referees by 15 March, 1960, to Secretary, Inter-University Council for Higher Education Overseas, 29, Woburn Square, London, W.C.1, from whom further particulars may be obtained. E8782

UNIVERSITY OF LONDON KING'S COLLEGE

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for this post. Candidates should have a good Honours degree and some experience of teaching and/or research in Engineering Science. Industrial or other professional experience is also desirable.

The salary will be on the scale £900 by £50 p.a. to £1350 by £75 p.a. to £1650, with starting point according to qualifications and experience. A London allowance of £60, family allowances, and F.S.S.U. benefits will also be payable.

The formal conditions of appointment and application forms may be obtained from the Registrar, King's College, London, Strand, W.C.2. Completed forms must reach him by February 29th. E8707

LONDON COUNTY COUNCIL

WESTMINSTER TECHNICAL COLLEGE

TWO LECTURERS

London County Council, Westminster Technical College, Vincent Square, S.W.1.

TWO LECTURERS required, 1st September, 1960, or earlier if possible, for H.N.C. Civil Engineering Courses. Should be Graduates in Engineering or hold equivalent professional qualifications, and have had industrial and teaching experience.

Burnham F.E. salary scale : £1370 by £35 to £1550, plus London Allowance, £38 or £51 ; starting salary may be above minimum if justified by industrial experience and present position.

Application forms from Secretary of College, to be returned within 14 days. (156) E8753

UNIVERSITY OF LIVERPOOL

LECTURERS

Applications are invited for two posts of LECTURER in the Department of Building Science. The initial salary will be within the range £900–£1350 per annum, according to age, qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees and quoting ref. CV/E, should be received not later than 5th March, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E8717

UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF CIVIL ENGINEERING

LECTURER

Applications are invited for the post of LECTURER or ASSISTANT LECTURER IN CIVIL ENGINEERING. Candidates should have some experience in the field of engineering research.

Salary scales : Lecturer, £900 by £50 to £1350 by £75 to £1650, with an efficiency bar at £1300. Assistant Lecturer, £700 by £50 to £850. The initial salary will depend on qualifications and experience.

Further particulars should be obtained from the Secretary and Registrar, to whom applications (7 copies from United Kingdom applicants) should be sent not later than 1st March, 1960. E8762

PUBLIC APPOINTMENTS

UNIVERSITY OF NEW SOUTH WALES, AUSTRALIA

SENIOR LECTURER/LECTURER IN HIGHWAY ENGINEERING

The University invites applications for appointment to the positions of SENIOR LECTURER/LECTURER in its School of Highway Engineering.

Salary : Senior Lecturer, £A2224 range £A2574 per annum ; Lecturer, £A1524 range £A2124 per annum.

Commencing salary according to qualifications and experience.

Applicants must possess a Degree of high standing in Engineering and should have had experience in general civil engineering. Previous research experience and Corporate Membership of the Institution of Engineers of Australia is desirable.

Knowledge of one or more of the following subjects will be an advantage.

Soil mechanics, town planning, land drainage, quarrying, structural engineering and bridge design, reinforced concrete and prestressed concrete, road location and design, road construction and maintenance, bituminous construction and design of bituminous mixes, specifications, quantities and contract documents.

Successful applicants will lecture at post-graduate levels and participate in research programmes.

Appointees will be eligible for 12 months' study leave on full salary after 6 years of service.

Subject to passing a medical examination, the appointees will be eligible to contribute to the State Superannuation Fund.

First-class ship fares to Sydney of appointees and families will be paid.

Four copies of applications should be lodged with the Agent General for New South Wales 56–57, Strand London, W.C.2, and a copy forwarded by air mail in an envelope marked " University Appointment " to the Bursar, The University of New South Wales, Box 1, Post Office, Kensington, New South Wales, Australia, by 19th March, 1960. E8749

DEPARTMENT OF MAIN ROADS

NEW SOUTH WALES, AUSTRALIA

CIVIL ENGINEERS

CIVIL ENGINEERS for Department of Main Roads, New South Wales, Australia.

Applications are invited from Graduates (or Undergraduates in their final year) in Civil Engineering of a recognised British or Irish University, for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience, will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence, to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56, Strand, London, W.C.2. E8750

NORTH THAMES GAS BOARD

INFORMATION BUREAU, WATSON HOUSE

A vacancy has arisen in the Information Bureau at Watson House, Fulham, S.W.6.

Applicants should preferably have had District experience and should hold the Institution of Gas Engineers Higher Grade Certificate (Supply), or other suitable qualification.

Duties would include the preparation of reports from laboratory tests, together with interpretations of results.

Commencing salary would be within the range of £694–£843 per annum (A.P.T. Grades 6-7).

Applications, giving full details, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference TE/815. E8788

PUBLIC APPOINTMENTS

GUILDFORD, GODALMING AND DISTRICT WATER BOARD

APPOINTMENT OF SENIOR ENGINEERING ASSISTANT

Applications are invited for the appointment of SENIOR ENGINEERING ASSISTANT, at a salary in accordance with Grade A.P.T. II (£765–£880 per annum). Starting salary in accordance with age and experience.

Candidates should have had good experience in the general engineering work of a Water Undertaking, and have passed part of the Associate Membership Examination of the Institution of Civil Engineers.

The appointment will be subject to the National Scheme of Conditions of Service, the Local Government Superannuation Acts, and to the passing of a medical examination.

Applications, stating age, training, present and previous appointments and experience, and names and addresses of two referees, must be received by the Chief Engineer, " Branksome," Filmer Grove, Nightingale Road, Godalming, not later than Monday the 15th February, 1960.

Housing accommodation will be available for a married man. Car allowance payable on " Casual Users " basis.

H. C. WELLER,
Clerk to the Board.

Municipal Offices,
High Street,
Guildford. E8723

TYNE IMPROVEMENT COMMISSION

ASSISTANT ENGINEER AND ENGINEERING ASSISTANT

Applications are invited for appointment to positions of ASSISTANT ENGINEER and ENGINEERING ASSISTANT (CIVIL) in the Chief Engineer's Department of the Tyne Improvement Commission.

Applicants should be Associate Members of the Institution of Civil Engineers or be advanced towards professional qualifications in civil engineering with experience in the design, execution and maintenance of dock and harbour engineering works.

The commencing salaries, which will be fixed according to the qualifications and experience of the successful candidates, will be within the range of £650 to £1200 per annum. The appointments are pensionable and subject to the passing of a medical examination.

Applications, stating age, education, training, qualifications and details of experience, and giving the names and addresses of two referees, as to training and experience, should reach the undersigned not later than 29th February, 1960.

R. N. EGGLETON,
Secretary.

E8773

AIR MINISTRY

LONDON AND PROVINCES

ENGINEERING DESIGNER DRAUGHTSMEN

Air Ministry Works Designs Branch requires in London and Provinces ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days' leave per year initially. Overseas tours for which special allowances granted.

Salary in London ranges from £680 (at age 25) to £900 per annum for men ; from £673 to £868 per annum for women. Somewhat lower in Provinces. Commencing salary dependent on age, qualifications and experience.

Applicants, who must be natural born British subjects, should write to Air Ministry, W.G.c, Lacon House, Theobalds Road, London, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held, and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. E8431

PUBLIC APPOINTMENTS

RUGBY RURAL DISTRICT COUNCIL

WIBTOFT WATER SUPPLY CONTRACT NO. 12
WOLSTON AREA SEWERAGE AND SEWAGE PURIFICATION CONTRACT NO. 13

APPOINTMENT OF CLERK OF WORKS OR 2ND ASSISTANT RESIDENT ENGINEER

Applications are invited for appointment in either of the above capacities, to assist the Resident Engineer in the supervision of the following works :

The laying of 5½ miles of 6 inch and 9 inch concrete and salt-glazed ware sewers, the re-drainage of some 600 houses and the construction of three pumping stations and of sewage purification works for 5000 people.

Work on the Contract is already in progress, under the direction of the Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, London, S.W.1.

The salary for appointment in either capacity is £800 per annum and, subject to satisfactory service, the appointment will be for approximately 12 months and will be terminable by one month's notice on either side.

A car mileage allowance will be paid and the Council will be prepared to consider making housing accommodation available, if required.

Applicants, who must have had experience of similar work, should apply in writing to the undersigned not later than 6th February, 1960, giving full particulars of age, qualifications and experience, and the names and addresses of two persons to whom reference may be made.

Canvassing will disqualify.

H. A. WILDE,
Clerk of the Council.

Council Offices,
24, Warwick Street,
Rugby.
19th January, 1960. E8649

CITY OF BIRMINGHAM

SALVAGE DEPARTMENT

APPOINTMENT OF DEPUTY CHIEF ENGINEER

Applications are invited for the post of DEPUTY CHIEF ENGINEER in the above Department, at a salary within the range £1220–£1375.

Candidates must be Corporate Members of the Institution of Mechanical Engineers and the person appointed will be responsible for the installation and maintenance of the mechanical and electrical plant, and for building work, at the various Refuse Disposal and Salvage Works of the Department.

Full details of the appointment may be obtained from the undersigned, to whom completed applications must be delivered not later than Friday, 4th March, 1960.

ALAN E. BARTON,
General Manager.

Civic Centre,
Broad Street,
Birmingham, 1. E8757

CITY OF BIRMINGHAM

SMOKE INSPECTOR

Applications are invited for the above post from candidates possessing either the Ministry of Transport (Steam) Engineering Certificate or equivalent, or from qualified Public Health Inspectors holding the Royal Society of Health Smoke Inspectors Certificate.

Duties are both advisory and statutory relating to abatement of Atmospheric Pollution from fuel burning installations and trade processes, abatement of industrial noise and testing of appliances under the Heating Appliances (Fireguards) Act, 1952.

Salary £880–£1065 according to qualifications and experience ; superannuation scheme ; medical examination. Applications, stating age, qualifications, present occupation and salary, length of service and experience with names of two referees to the Medical Officer of Health, Congreve Street, Birmingham, 3, before 27th February, 1960. E8737

Classified Advts. continued on page 112

PUBLIC APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD

EASTERN DIVISION

SENIOR DRAUGHTSMEN

Applications are invited for the following appointments in the Generation Department (Construction Section) at Divisional Headquarters (Cockfosters in North London).

SENIOR DRAUGHTSMAN

Salary : N.J.B., Schedule D, Grade 4, £980 by £20 to £1080, inclusive of London Weighting.

The duties of the successful applicant will include work on the layouts for high voltage transmission lines and substations involving the preparation of overhead line profiles and substation and switchgear arrangements and associated civil engineering works.

Applicants should have technical qualifications, preferably to the standard of Higher National Certificate, and should have had experience of this type of work.

SENIOR DRAUGHTSMAN

Salary : N.J.B., Schedule D, Grade 5, £830 by £20 to £940, inclusive of London Weighting.

The duties of the successful applicant will include work on the layouts for high voltage transmission lines and substations.

Applicants should have technical qualifications to the standard of Ordinary National Certificate and should have had experience of this type of work.

Applications, quoting reference 2/11336, stating age, qualifications, experience and present position, should be sent to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts, to arrive not later than 13th February, 1960. E8726

MANCHESTER REGIONAL HOSPITAL BOARD

ARCHITECTURAL ENGINEERING AND SURVEYING STAFF

A substantial expansion of the hospital capital building programme offers valuable opportunities to ambitious Architects, Engineers, and Surveyors. Vacancies are available in the following grades. The salary scales quoted are at present under review.

(a) Principal Assistant, Grade Scale II—£1195–£1420 year ; ARCHITECTS
(b) Senior Assistant Grade—£1050–£1245 a year ; ARCHITECTS, QUANTITY SURVEYORS, ENGINEERS (Mechanical, Heating and Ventilating), ENGINEERS (Electrical).
(c) Assistant Grade—£730–£1055 a year ; ARCHITECTS, SURVEYORS (Land and Quantity), ENGINEERS (Mechanical, Heating and Ventilating), ENGINEERS (Electrical).
(d) Sub-professional Grade—£545–£765 a year ; ARCHITECTS, SURVEYORS (Land and Quantity).
(e) DRAUGHTSMEN—£445–£660 a year.

Candidates for posts listed under (a), (b) and (c) must possess full professional qualifications, and for posts under (d), intermediate qualifications. Draughtsmen must have had at least 3 years' previous experience. All posts are subject to National Health Service conditions and are superannuable. Application forms, to be returned by 29th February, 1960, are obtainable from the Secretary of the Board, Cheetwood Road, Manchester, 8. E8730

MINISTRY OF TRANSPORT

CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential ; knowledge of Highways Authorities' procedure desirable. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London) £1300. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/64/7. E8794

STOKE-ON-TRENT HOSPITAL MANAGEMENT COMMITTEE

DEPUTY SUPERINTENDENT ENGINEER

The Group comprises eighteen hospitals, and the person appointed will act as DEPUTY to the SUPERINTENDENT ENGINEER over the whole range of duties, including planning and maintenance of steam boiler plant, heating and hot water services, and electrical services. Candidates must possess the Higher National Certificate in Mechanical or Electrical Engineering or equivalent, and must be able to prepare drawings and specifications.

Commencing salary : £805, rising by five annual increments to £940 per annum.

Written applications, with the names of two referees, to Group Secretary, Stoke-on-Trent H.M.C., Princes Road, Stoke-on-Trent, as soon as possible. E8769

WOKING AND CHERTSEY GROUP HOSPITAL MANAGEMENT COMMITTEE

WORKS ASSISTANT

WORKS ASSISTANT required to assist Building Supervisor with hospital building maintenance.

Salary, at age 21, £415 per annum, rising to £625 per annum.

Apply, stating age, experience and qualifications, &c., within 10 days, to Group Secretary, "Huntington," Guildford Road, Chertsey, Surrey. E8747

TENDERS

COMMISSIONERS FOR THE PORT OF CALCUTTA

CHIEF MECHANICAL ENGINEER'S DEPARTMENT

INVITATION TO TENDER

TENDERS are invited from experienced firms for the CONSTRUCTION, SUPPLY and DELIVERY AFLOAT at the Port of Calcutta in accordance with the Specification, the Contract Drawings and the Conditions of Contract complete in all respects for the service intended of :

ONE TWIN SCREW STEAM 30 TONS CRANE VESSEL

so as to reach the Chief Mechanical Engineer, Calcutta Port Commissioners, 8, Garden Reach Road, Kidderpore, Calcutta, 23, not later than 1700 hours I.S.T. on the 29th day of April, 1960, and the Consulting Engineers not later than 11.30 hours G.M.T. on the same day.

Principal particulars of the vessel and crane are as follows :

Length overall, 156ft. 6in.; length between perpendiculars, 150ft.; beam moulded, 43ft.; freeboard minimum 5ft.; draught aft 9ft.

Main hoist 30 tons ; 60ft. maximum radius ; 87ft. lift of hook above water level.

Auxiliary hoist 15 tons ; 82ft. maximum radius ; 96ft. lift of hook above water level ; lift of each hook below water level 35ft.

Tender Documents may be obtained either from the Chief Mechanical Engineer, Calcutta Port Commissioners or from the Consulting Engineers, Messrs, Rendel, Palmer & Tritton, 125, Victoria Street, Westminster, London, S.W.1, on deposit with the Treasurer, Calcutta Port Commissioners, 15, Strand Road, Calcutta, or with the Consulting Engineers of the sum of £1,000 or Rs. 13,333/- as "Earnest Money," which will be refunded to unsuccessful tenderers on the award of the tender being made, and in the case of the successful tenderer this amount will be adjusted towards the security deposit. The cost of Tender Documents, which will not be refunded amounting to £3 or Rs.40/- per copy should be paid together with the Earnest Money.

Tenders in sealed envelopes, endorsed on the outside "TENDERS FOR NEW 30 TONS CRANE VESSEL" are to be submitted in triplicate of which two copies are to be sent to the Chief Mechanical Engineer and the remaining copy to the Consulting Engineers.

Tenders will be opened at the offices of Messrs. Rendel, Palmer & Tritton, and the Chief Mechanical Engineer shortly after the closing time referred to above and any tenderer who wishes to be present at the time of opening may do so.

Quotations from the Tenderers must be firm and remain open for a period of 16 weeks from the closing date.

The Calcutta Port Commissioners do not bind themselves to accept the lowest or any tender and reserve the right to accept or reject any tender without assigning any reason.

S. K. MITRA,
Chief Mechanical Engineer.
E8719

COUNTY BOROUGH OF SWANSEA

WATER DEPARTMENT

TENDER FOR SURPLUS PLANT

TENDERS are invited for the PURCHASE of the following :

WINGET-PARSONS Model 221 BOOM-TYPE TRENCHER, Machine No. TR.221/63. Purchased August, 1953, now surplus to requirements. The machine is powered by Leyland Diesel engine and fitted with bucket chain for 24in. wide trench to maximum depth of 8ft. 6in. and complete with set of side cutters to dig trenches of 36in. width.

The Machine may be inspected on application to T. Price, Esq., M.I.C.E., M.I.W.E., Borough Water Engineer and Manager at the undermentioned address.

Tenders in a plain sealed envelope and bearing no name or mark to indicate the sender and endorsed "Tender for Trencher," should be delivered to the undersigned on or before 27th February, 1960.

The Council does not bind itself to accept the highest or any tender.

T. B. BOWEN
Town Clerk.

The Guildhall,
Swansea.
26th January, 1960. E8744

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

	Quantity required
MAIN BAR FRAMES with Frame Clips completely machined on all faces for W.P. and W.G. Locomotives.	30 L.H. 30 R.H.

Forms of Tender may be obtained from the above address on or after the 5th February, 1960, upon payment of a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenderers must send their Tenders so as to reach this office by 2 p.m. on Thursday, 10th March, 1960. Please quote reference No. 59/59.DB/RLY.2. E8751

FYLDE WATER BOARD

TWO CENTRIFUGAL PUMPS

TENDERS are invited for TWO CENTRIFUGAL PUMPS each 3½ m.g.d. rated capacity—one water turbine driven ; one driven by variable speed electric motor, for Board's Laund Wood Pumping Station, Whitewell.

Further particulars and tender documents can be obtained from the Engineer to the Board, Sefton Street, Blackpool.

Tenders must be received not later than 8th April, 1960. E8755

TENDERS

URBAN DISTRICT COUNCIL OF BRAINTREE AND BOCKING

CODHAM MILL WATER SCHEME

TENDERS FOR PUMPING MACHINERY

The Council are about to purchase ELECTRIC PUMPING MACHINERY with STANDBY OIL PLANT for the development of a new source of water supply.

The Machinery will consist of :

CONTRACT No. 2.

(a) Duplicate Booster Pumps, each capable of pumping 1 m.g. in 16 hours against a head of approximately 150ft.
(b) Duplicate Booster Plant consisting of electrically driven pumps, each capable of pumping at the rate of 20,000 g.p.h. against a head of approximately 110ft.
(c) Booster Pumping Machinery to pump at the rate of up to 165,000 g.p.h. into supply under a variable head not exceeding approximately 100ft.
(d) An Oil Driven Generator as a standby to run an electrically driven set (part of (c) above). Duty of pump 65,000 g.p.h.

CONTRACT No. 3.

Three Submersible Pumps, each capable of pumping 1 m.g. in 16 hours against a head of approximately 220ft.

The same Contractor is at liberty to Tender for both Contracts Nos. 2 and 3. It is suggested, however, that he should make his own arrangements and submit the oil-driven generator as a subcontract if he does not manufacture such machinery himself.

Contractors are to apply, in the first instance, immediately to HERBERT LAPWORTH PARTNERS, 25, Victoria Street, Westminster, S.W.1, to be placed on a selected list.

W. BALSON,
Clerk of the Council.
Town Hall,
Braintree, Essex. E8792

INDIA SUPPLY MISSION

The Office of India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, invites TENDERS for the following :

TENDER ENQUIRY No. SE.139.

"For the SUPPLY of 2 (Nos.) BOREHOLE PUMPS ; 200 g.p.m., against 200ft. hd. Maximum diameter of pump to be 7½ inches."

Specifications, &c., relative to the above, can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of 14 shillings and 3 pence per Tender, and is not refundable. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington 8, D.C., United States of America, so as to reach them by 22nd March, 1960.

Specimen copy of the above enquiry can be seen at India Store Department, Engineering Branch, Bromyard Avenue, Acton, W.3, under the following reference : S.3926/59/NSC/ENG.2. E8766

EDUCATIONAL

UNIVERSITY OF EDINBURGH

POST-GRADUATE SCHOOL OF APPLIED DYNAMICS

A POST-GRADUATE COURSE, leading to the Diploma in Applied Dynamics of the University, will be given in the Department of Engineering from October, 1960, to June, 1961. Lectures will be given on mechanical vibration, gyrodynamics and control systems. Laboratory work will be undertaken also.

Further particulars and application forms may be obtained from the Faculty of Science Office, Department of Chemistry, West Mains Road, Edinburgh, 9.

A student who wishes to be considered for a D.S.I.R. Advanced Course Studentship must apply to the University as soon as possible.

CHARLES H. STEWART,
Secretary to the University.
January, 1960. E8761 E

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

EDUCATIONAL

ADMIRALTY

ROYAL CORPS OF NAVAL CONSTRUCTORS

SCHOOLS ENTRY

A competition for entry into the Royal Corps of Naval Constructors will be held in July, 1960.

2. Accepted candidates will be established as probationers in the Royal Corps of Naval Constructors and will undergo a two-year course of training at the R.N. Engineering College, Manadon, and in H.M. Dockyard, Devonport, followed by a three-year course at the R.N. College, Greenwich.

3. Candidates must be aged between 17 years 6 months and 19 years 6 months, inclusive, at 1st September, 1960.

4. Candidates with the General Certificate of Education will be required to have passed at Advanced Level in at least Pure Mathematics, Applied Mathematics, and Physics taken on the same occasion, and at least Ordinary Level passes in English and a language other than English.

5. Candidates with the Scottish Leaving Certificate will be required to have Higher grade passes in Science (to include Physics), Mathematics, at least two additional mathematical subjects (one of which must be Dynamics), and at least lower grade passes in English and a language other than English. Passes to be gained at not more than two sittings of the Scottish Leaving Certificate examination.

6. Candidates with the Northern Ireland Grammar School Senior Certificate will be required to have passes at Advanced Level in Mathematics (General Course, Pure Mathematics, Applied Mathematics) and Physics—taken on the same occasion ; and at least Ordinary Level passes in English and a language other than English.

7. Applications will be considered from candidates who sit these examinations in 1960.

8. The work of the R.C.N.C. covers all aspects of design, construction and repair to H.M. Ships. Members undertake to serve wherever required at Admiralty headquarters, Outports in the United Kingdom and at Royal Dockyards at home and abroad.

9. The starting pay of a probationer at age 18 will be £545. A deduction of £75 is made when living in at the R.N. Engineering College, Manadon, or at the R.N. College, Greenwich. The successful probationer can expect an appointment as Assistant Constructor at age 23 or 24 with a starting salary of not less than £910 and £940 respectively. Promotion to Constructor normally takes place at about age 30 with a salary which may be expected to be not less than £1515 rising in nine years to not less than £2255. Promotion to higher ranks is by selection.

10. Full particulars may be obtained from the Secretary of the Admiralty, Civil Establishments Branch 11(88), Empire Hotel, Bath, quoting reference number 6015 to whom final application must be submitted by 16th May, 1960. E8783 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A LEADING TARIFF COMPANY invites applications for position in Electrical Department from men aged between 25 and 30. G.C.E. or equivalent and a general engineering background, conversant with production and planning methods, prime movers and power supply ; able to assess effects on production caused by stoppage of machinery in all types of factories. Suitable training given in insurance principles. Based on London, but must be prepared to travel. Good prospects. Non-contributory pension and other benevolent schemes.—Write in confidence to BOX No. E8754, "The Engineer." A

A YOUNG MAN about 23 years of age is required to fill the vacancy of ASSISTANT TO TECHNICAL MANAGER, of an expanding rubber company near London. It is intended that the successful applicant will eventually succeed the Technical Manager. The vacancy will interest men studying for G.I.M.E. The post requires a man capable of carrying out liaison work with customers and of carrying to fruition investigations relating to production problems. Commencing salary, £600 per annum, with participation in Staff bonus scheme. Reply in confidence.—BOX No. E8519, "The Engineer." A

CENTRIFUGAL PUMP DESIGNER required for South East England. Applicants must be experienced in modern Pump Practice and High Specific Speed Axial and Mixed Flow Designs.—Applicants should give details of age, experience and salary required to BOX No. E8756, "The Engineer." A

TRAIN FOR A CAREER IN TEACHING ENGINEERING SUBJECTS

Persons aged between about 25 and about 45, with good industrial experience, are invited to apply for training as FULL TIME TEACHERS OF ENGINEERING SUBJECTS IN TECHNICAL COLLEGES AND SCHOOLS.

EXCELLENT CAREER PROSPECTS

NEXT COURSE : SEPTEMBER 1960, TO JUNE 1961

Applicants should hold suitable qualifications, e.g. a university degree, associate or graduate membership of a professional institution, Higher National Certificate, Final or Full Technological Certificate of the City and Guilds of London Institute.

NO TUITION FEES

PERSONAL, MAINTENANCE, DEPENDANTS' AND TRAVELLING GRANTS PAYABLE

For details write immediately, quoting S/36 to either

The Director, Bolton Training College, Manchester Road, Bolton.
The Director, Huddersfield Training College, Holly Bank Road, Huddersfield.
The Principal, Garnet College, 83 New Kent Road, London S.E.1.

E8728 E

SITUATIONS VACANT

APPLICATIONS ARE INVITED from ambitious and resourceful men to fill the position of TECHNICAL ASSISTANT to the Sales Manager of Electric Lamp Machinery Manufacturers near London. A permanent, progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade.—Applications, with full particulars of education, experience and salary required, to BOX No. E171, "The Engineer." A

CENTRALUBE, LTD., Lubrication Engineers, require the following Mechanical Engineers, preferably qualified, with heavy Engineering and/or sales experience: PERSONAL ASSISTANT to Chief Engineer, based at Head Office, London. AREA ENGINEERS for Scottish and Yorkshire Areas. ENGINEERS for London Office, N.18.—Full details of age, experience and salary required, in confidence to Managing Director, Centralube, Ltd., Park Royal Road, London, N.W.10. E8735 A

CIVIL ENGINEER, aged 25–28, preferably single, required by large merchant company with London Head Office and extensive overseas interests for the Engineering Department of their Associated Company in the Federation of Malaya. Applicants should be Graduate or Associate Members of the Institution of Civil Engineers or have academic qualifications acceptable to the Institution, which the successful candidate would be required to join. The Department markets a wide range of engineering products and the post requires some experience and interest in mechanical engineering. Housing provided at nominal rent. Frequent U.K. leave with paid passages. Medical scheme. Contributory retirement schemes. Remuneration and other benefits will be discussed at interview.—BOX No. E8752, "The Engineer." A

CIVIL ENGINEER required by Consulting Engineers, London office, engaged on large irrigation schemes abroad. Candidates up to 30 years of age who are University Graduates and/or A.M.I.C.E. with experience in hydraulics and the design of reinforced concrete structures should apply within 14 days stating experience and salary required to BOX No. E2705, "The Engineer." A

CIVIL ENGINEERING CONTRACTORS have vacancies in Scotland for SENIOR CIVIL ENGINEERS with good site experience and ability to take charge of works.—Applicants should give full details of qualifications and experience and state salary expected to BOX 379, Robertson & Scott, 42, Charlotte Square, Edinburgh. E8732 A

DESIGN ENGINEERS

An Engineering firm of repute in the Eastern Counties has vacancies for TWO EXPERIENCED DESIGN ENGINEERS.

One, age 25–30, minimum qualifications H.N.C. or equivalent.

One, age 30–36, minimum qualification graduateship or Associate Membership of Inst. Mechanical Engineers to assume responsible position after acquiring knowledge of Company's products.

Candidates must show ability to produce sound designs for interesting work involving structural as well as mechanical engineering. Experience in the design of medium/heavy mechanical handling and/or construction equipment an advantage.

Attractive salaries to suitable applicants. There is a Contributory Pension Scheme and good canteen facilities.

Write in confidence giving full information about qualifications, experience and salary required, quoting A.6084 to

WRIGHT ATKINSON, LTD.,
Employment Consultants,
70, Queen Victoria Street,
London, E.C.4.

E8741 A

DESIGNER DRAUGHTSMAN.—Vacancy for Draughtsman aged 28–35, with National Certificate in Mechanical Engineering and works training, also design experience in general mechanical engineering or in some of the following: chemical and process plant, refrigeration, mechanical handling plant, services, and plant layout. Excellent amenities, five day week, three weeks' holiday, non-contributory pension scheme. Commencing salary within the range £950–£1100 per annum.—Apply in writing, giving full details, to Personnel Manager, Arthur Guinness Son and Co. (Park Royal), Ltd., London, N.W.10. Ref. DRA/TE. E8724 A

DRAUGHTSMAN MECHANICAL (SENIOR) required by the British Drug Houses, Ltd. for layout and special machine development in their chemical laboratories. H.N.C. or equivalent preferred. Five-day week, Canteen, Sports Club, Pension and Profit Sharing Schemes.—Apply in writing, stating age and educational attainments to the Staff Manager, Graham Street, City Road, N.1. E8745 A

ENGINEERING DRAUGHTSMEN

There are vacancies for Draughtsmen at the various Birmingham Works of the West Midlands Gas Board. The posts are on the staff of the Divisional Engineer and offer excellent opportunities for gaining experience in a wide field of engineering activity.

One post is within the salary range of £733 to £927 per annum and candidates should hold a Higher National Certificate in Civil or Structural Engineering or equivalent qualification.

The remaining posts are within the salary range of £629 to £709 or £629 to £813 per annum according to experience. Candidates for these posts should have completed a drawing office apprenticeship or have equivalent experience and have reached at least Ordinary National Certificate level in Civil, Mechanical or Structural Engineering.

Pension scheme and attractive conditions of service.

Applications, stating age, qualifications and experience, should be addressed to Mr. J. E. Wakeford, Divisional General Manager, West Midlands Gas Board, Edmund Street, Birmingham, 3. E8770 A

ENGINEER SURVEYOR required for inspection of Cranes and other Lifting Tackle. Must have drawing office experience in design of Cranes and hold National Certificate for Mechanical Engineering. Relief work and in specified areas. Commencing salary £800. Non-contributory Retirement Pension, &c.—Apply Eng. Dept., GENERAL ACCIDENT ASSURANCE CORP., LTD., 99, Aldwych, London, W.C.2. E8791 A

ENGINEERING, PHYSICS AND SCIENCE GRADUATES OR EQUIVALENTS required for new appointments involving research, design and development work on (1) Dynamic behaviour of machine tools and problems associated with automatic control; (2) Press working processes, cold extrusion and other new techniques for the forming of metals; (3) Machining processes; intitially work will be concerned with the appraisal of new machining developments or studies of machining costs on a comprehensive scale; (4) Mechanical engineering equipment including special machine tools, presses, mechanisms, test rigs, &c. Successful candidates will be expected to take complete responsibility for projects from conception to completion. Capacity for creative thinking and initiative are important. The conditions of employment are attractive and there are excellent prospects for advancement. Superannuation scheme. Removal expenses paid.—Send full details in confidence to the Secretary (R.635), Production Engineering Research Association, Melton Mowbray, Leics. E8697 A

EXPERIENCED WORKING PRECISION INSTRUMENT MAKER, 30–40, take charge small workshop, organise work, &c. Reliability and good personal references essential, Haslemere district.—Write full details experience, age, salary expected—BOX No. E2708, "The Engineer." A

HEATING & VENTILATING ENGINEER, experienced all types ventilating and heating, capable taking complete charge of contracts. Good salary, pension scheme and L.V.—Write in confidence, giving age, experience and salary expected to The Secretary, Carrier-Ross Engineering Co. Ltd., 22A, Cavendish Square, London, W.1. E2685 A

INSTRUMENT MAKER. Electrical and Mechanical required. Applicants should be fully conversant with the maintenance of all modern industrial instruments and capable of making and testing such apparatus. Please write, giving full particulars of experience and age to Works Personnel Officer, Thames Board Mills Limited, Purfleet, Essex. E8757 A

IRRIGATION ENGINEER, age not less than 30, with at least 5 years' experience in design and/or construction of irrigation and reclamation schemes, wanted for six months' service as the Engineer Member of a Food and Agricultural Organisation Mission on the Lower Volta, Ghana. Air passages, kit allowance, free bachelor accommodation.—Apply, Sir William Halcrow and Partners, Alliance House, Caxton Street, London, S.W.1. E8727 A

JACKSON BROS. (OF KNOTTINGLEY), LTD.

require a DRAUGHTSMAN for work in modern, glass-producing factory on bottle-mould design. Experience in this class of work is desirable, but not essential. Canteen facilities.—Apply Personnel Officer, Jackson Bros. (of Knottingley), Ltd., Headlands Lane, Knottingley, Yorkshire.

E8484 A

JUNIOR MECHANICAL ENGINEER OR DRAUGHTSMAN with experience in chemical or similar engineering, required now by Arthur Guinness Son & Co. (Dublin) Limited, St. James's Gate, Dublin: age limit 26; must have H.N.C. or equivalent in engineering, good practical apprenticeship, and at least one year's drawing office experience on process plant and general engineering. Starting salary in range £640 to £970 p.a., according to age and qualifications with annual advances. Substantial amenities and excellent prospects for progressive man. Reply to Chief Engineer with particulars of age, education, training, and experience, in that order. Expenses paid if selected for interview. E8678 A

MECHANICAL ENGINEER

Position of senior responsibility for Engineer of Higher National Certificate standard or above, and preferably A.M.I.Mech.E. qualification. Age up to 45 years and proved ability to direct work of other technicians.

Our principal products are mobile generating plants and associated control gear of advanced design. To work on their mechanical development we need an Engineer experienced in stress-analysis of high-speed rotating machines and in structural design of chassis and similar fabrications. Successful familiarity with heat transfer problems is an associated requirement.

Applications will receive strictly confidential appraisal by Technical Director.

VERNONS INDUSTRIES LIMITED,
Kirkby Industrial Estate,
LIVERPOOL.

E8729 A

PILKINGTON BROTHERS LIMITED have a number of vacancies for experienced MECHANICAL DRAUGHTSMAN DESIGNERS and MECHANICAL DRAUGHTSMEN. The work would include design work of light, medium and heavy machines, under the direction of the Chief Designer in the Central Engineering and Planning Department.

Minimum qualifications—H.N.C. Good drawing office experience.

Assistance with house purchase, recreational and canteen facilities, five-day week, superannuation scheme.

Applications should be addressed to Group Staff Department, Pilkington Brothers Limited, Grove Street, St. Helens, Lancashire. E8748 A

QUALIFIED CIVIL ENGINEER required for position of Resident Engineer in charge of Airport buildings and constructional work in West Africa. The appointment will be for 3 years subject to home leave.—Applicants to forward particulars of training and experience by 7th March, 1960, to Norman & Dawbarn 7, Portland Place, W.1. E2710 A

REPRESENTATIVES required on generous commission basis to introduce world renowned Pipe Cutting and Screwing Machines and other equipment.—BOX No. E2707, "The Engineer." A

RESEARCH AND DEVELOPMENT ENGINEER
required
for work on the
COMBUSTION OF LIQUID FUELS

This position offers the successful candidate outstanding opportunities to carry out work, from fundamental research to commercial development, in the field of oil burning, in the newly-formed Research Department of one of the pioneer companies of this Industry.

Applicants should have a degree in Mechanical Engineering or equivalent qualifications. Experience either in combustion or aerodynamics is desirable but consideration will be given to candidates without this experience who are otherwise suitable.

The Company operates a contributory superannuation fund and a life assurance scheme.

Applications, which will be treated in strict confidence, should include details of age, education, experience and salary required, and be addressed to BOX No. E8575, "The Engineer."

SENIOR DRAUGHTSMAN.—May and Baker, Ltd., Dagenham, Essex, require a Senior Draughtsman with experience in the design and layout of chemical or similar plant installations. Applicants should have technical qualifications to Ordinary National Certificate level or higher. Salaries are reviewed annually. There is a pension fund and life assurance scheme in operation. Excellent canteen and sports facilities.—Apply initially in writing to the Personnel Officer, quoting Reference No. 19/60. E8709 A

SENIOR ENGINEER.—Well-known British organisation has immediate vacancy for a Senior Engineer in Brazil. Applications will only be considered from men aged 35–45 who can offer really good experience of maintenance of Refrigeration and Factory equipment. Preference will be given to candidates who can also offer experience of building maintenance. For the right man, well educated and with the all-round experience required, the prospects are excellent.—Write in strict confidence, giving age and details of experience to BOX No. E8733, "The Engineer." A

STEEL WORKS PLANT DESIGNERS

Openings offering good prospects are available for designers of proved ability with experience in Heavy Steel Works Plant, Heavy Shears, Handling Equipment and Ancillary Gear.

Applicants should be able to work out general designs to meet specifications, discuss requirements with customers and supervise preparation of detailed assemblies and drawings for manufacture.

In the first instance please give full details of age, training and experience.

Write BOX No. E8740, "The Engineer."

STEWARTS AND LLOYDS, LIMITED
require a
METHODS ENGINEER

to take charge of the Methods Department at their TOLLCROSS STEEL FOUNDRY near GLASGOW.

Applicants should preferably have worked with both alloy and plain carbon steel castings, in the weight range up to 6 tons, but more important is a thorough practical knowledge of modern steel foundry methoding.

Written applications, giving full particulars of age, education and experience, should be sent to the Manager, Personnel Services, Clyde Tube Works, Coatbridge, Lanarkshire. E8680 A

TECHNICAL ASSISTANT required for Plant Records at Head Office and Stock-taking on Civil Engineering Sites throughout Great Britain.—Please send particulars of experience, qualifications, age, salary required, &c., to Director (Equipment), West's Piling & Construction Co., Ltd., Bath Road, Harmondsworth, Middlesex. E2700 A

THE MANCHESTER SHIP CANAL COMPANY

The Manchester Ship Canal Company invite applications for the appointment of ASSISTANT CIVIL ENGINEERS and DESIGN ENGINEERS on the established staff of the Chief Engineer. Scale of salaries: £805 at age 25, rising by annual increments to £1250 at 38, with prospects of promotion to higher grades at salaries up to £1720.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications, and should have experience in design, specifications, construction and maintenance of Civil Engineering Works. Harbour and dock experience is preferable but not essential.

Successful applicants will require to become members of the Company's Contributory Superannuation Scheme.

Applications, stating age, qualifications and experience, should be addressed to the Chief Engineer, The Manchester Ship Canal Company, Ship Canal House, King Street, Manchester, 2, not later than 13th February, 1960.

E8560 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

SENIOR ENGINEER required to take charge of building services design teams. Candidates to be thoroughly experienced in all aspects of building services work, particularly in the design of heating, ventilating and electrical services. Minimum qualification Associate Membership of the Mechanical or Electrical Institutions. The successful candidate will be considered for the position of Associate with this firm.—Applications giving age, experience and salary required to Norman and Dawbarn, Architects & Consulting Engineers, 7, Portland Place, W.1. E2709 A

WORKS MANAGER with knowledge of tube manufacture. Must have wide experience in practical and executive appointments, held similar positions and be a first-class administrator. Substantial salary will be paid to man with necessary qualifications, and future prospects are excellent.—Apply in confidence to the Managing Director, The Phoenix Steel Tube Co., Ltd., Phoenix Street, West Bromwich. E8644 A

YOUNG MECHANICAL ENGINEER desirous of working on the commercial side (not sales) required for the London Office of an overseas Engineering Company.—Applications giving details of age, education, training, experience, and salary required to Box 5286, Frost-Smith Advg., 64, Finsbury Pavement, London, E.C.2. E8774 A

YOUNG SALES ENGINEER required by Importers of Continental Machines for Woodworking and Plastics Industry. Previous sales experience not essential but knowledge of German advantageous.—BOX No. E2696, "The Engineer." A

CHIEF PROCESS ENGINEER

Minimum B.Sc. Chemical Engineering, A.M.I.Chem.E., with considerable post-degree industrial experience, including minimum 4 years in chemical process design engineering. Must have held responsible position in a process design department, be completely familiar with mass and heat transfer equipment and be able to evaluate equipment design. Responsibilities will include the direction and control of the Company's process design of complete low temperature plants from sales inquiry stage to commissioning.

Apply:

Personnel Manager,
AIR PRODUCTS (GB) LTD.,
49-50, Poland Street,
London, W.1.

E8772 A

CHANCE BROTHERS LIMITED

Glass Manufacturers

A vacancy has arisen for a Graduate Engineer.

The vacancy is in the Development Department. The Company regards the position as one of considerable importance and the intention is to appoint a man who may succeed to a leading position in the Department.

Previous experience in the glass industry is not essential.

Applications should be addressed to the Secretary, Chance Brothers Limited, Smethwick 40, Birmingham. E8777 A

CHIEF DESIGNER

Applications are invited for the post of Chief Designer in a Structural Engineering Company in the Lanarkshire area. The post is a senior one and candidates should be between 35 and 45 years of age and should have a University degree or M.I.Struct.E. The Company is engaged in the fabrication of medium-type buildings and a wide range of experience in the design of conventional truss and portal frame structures is necessary. The successful candidate will be required to control a small team of Designers and be able to take decisions on his own initiative. The post is a permanent one and carries with it the benefits of contributory pension scheme and 5-day week. A salary in the region of £1200 per annum would be considered for a suitable candidate.—Please reply, giving complete details of education, qualifications, training and experience to BOX No. E2703, "The Engineer." A

Classified Advts. continued on page 114

SITUATIONS VACANT

CLERK OF THE WORKS

A major Engineering Company of international repute and in the lead in its product fields wishes to appoint a Clerk of the Works at its largest establishment bordering on the Home Counties. The candidate, who should be well equalified in this field, must have both Civil and General Engineering experience as his duties will include the follow up of all work carried out by the Works Engineering Department, ensuring that correct estimates are given and that work is completed on schedule. Salary will be commensurate with experience, and the post offers considerable opportunity for promotion.

Applications with full curriculum vitae including details of salaries earned may be made in strict confidence to Box No. 3164, c/o Charles Barker & Sons, Ltd., Gateway House, 1, Watling Street, London, E.C.4.

E8743 A

SITUATIONS VACANT

DESIGN ENGINEER

required with experience of Charging and Defuelling Equipment, Fuel Element handling and shielding, in connection with Nuclear Projects.

Applicants with an Engineering Degree will be preferred, and full particulars stating age, qualifications and past experience should be sent to :

N.P.E.,
VICKERS-ARMSTRONGS (ENGINEERS), LTD.,
Naval Construction Works,
Barrow-in-Furness, Lancs.

E8765 A

SITUATIONS VACANT

PROJECTS ENGINEER

CHEMSTRAND LIMITED

have a vacant appointment in their works at Coleraine, Northern Ireland, for a fully qualified MECHANICAL ENGINEER to assist in Plant Development and Improvement Projects under the Engineering Department Superintendent.

Applicants should be in the 25–35 age group and preferably with experience in the Chemical or Petroleum Industries. Qualifications in Chemical Engineering would be an advantage.

Generous starting salary, pension and Life Assurance Schemes and other big Company benefits. Housing is available locally and the company pays joining expenses.

Please apply in confidence to
THE STAFF PERSONNEL MANAGER, CHEMSTRAND, LTD.,
8, WATERLOO PLACE, LONDON, S.W.1,
quoting Ref. PCE.2.

E8746 A

SITUATIONS VACANT

STRUCTURAL DRAUGHTSMAN

Applications are invited for the post of Squad Leader in the Drawing Office of a Structural Engineering Company in the Lanarkshire area. Candidates should be between 35 and 45 years of age and should have served an apprenticeship in an Engineering Workshop and had about 15 years' experience. Experience of detailing heavy Structural Steelwork is essential. The successful candidate will control a team of Draughtsmen. This is a senior post and a salary of £900 per annum will be paid to the successful applicant. The post is a permanent one and carries with it the benefits of contributory pension scheme and 5-day week.—Please reply giving complete details of education, training and experience to BOX No. E2704, "The Engineer." A

GEORGE WIMPEY & CO., LIMITED

invite applications for the following appointments in an expanding and progressive department engaged in design and planning of Oil Refinery and Chemical Plants.

DESIGN ENGINEERS with considerable experience in Oil Refinery and Chemical Plant design and in the preparation of indents, analysis of specifications and quotations for pumps, vessels, compressors and similar equipment. Minimum qualification H.N.C. (Mech.).

DRAUGHTSMEN with at least three years' experience in PLANT LAYOUT and/or PIPING and/or INSTRUMENTS. Minimum qualification O.N.C. (Mech.).

Permanent appointments ; contributory pension scheme after probationary period ; good office accommodation ; canteen facilities.

Applications, giving age, qualifications and full details of experience, to :

SPECIAL PROJECTS OFFICE,
191A, Askew Road, Shepherds Bush, London, W.12.

E8742 A

AIR PRODUCTS (G.B.) LTD.

ENGINEERING MANAGER

A well qualified senior chemical or mechanical engineer is required to head our engineering department.

He will be responsible to the Managing Director for all the engineering activity of the Company which is engaged in the design, manufacture and erection of low temperature process plant for the chemical, gas and steel industries.

The activities of our well established Company are expanding rapidly. This vacancy offers, therefore, outstanding opportunities for the really ambitious executive engineer.

Applications will be treated confidentially and should be addressed to :

Personnel Manager,
AIR PRODUCTS (G.B.) LTD.,
St. Giles House, 49/50, Poland Street, London, W.1.

E8771 A

CENTRAL ELECTRICITY GENERATING BOARD

DESIGN AND CONSTRUCTION DEPARTMENT

Headquarters, London, S.E.1.

POWER PLANT DESIGN BRANCH

ASSISTANT ENGINEER required in the **Boiler Plant Section** to join a team engaged in the development of boiler design and in the checking and analysis of boiler tenders. Duties will include keeping the Board's boiler specification under continuous review in collaboration with other sections of the department.

Candidates should have a degree in Engineering and/or Membership of an appropriate professional Institution, and preferably should have experience in a boiler manufacturers' design department. The ability to write reports would be an advantage.

Salary within the scale £1,245—£1,605 p.a.

Applications, stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 15th February. Envelopes should be marked "Confidential Ref. ENR/25."

E8759 A

AIR PRODUCTS (G.B.) LTD.

INDUSTRIAL GAS DIVISION

GENERAL MANAGER

A fully qualified Chemical or Mechanical Engineer is required to head this newly established division of the Company.

He will organise, manage and control the sale, production and distribution of industrial gases. Applicants must have extensive experience in the sales and distribution of industrial gases or chemical products.

This is a top management position with outstanding opportunities for the right man.

Write to :

The Personnel Manager,
AIR PRODUCTS (GREAT BRITAIN) LTD.,
ST. GILES HOUSE,
49/50, POLAND STREET, LONDON, W.1.

E8768 A

Due to expansion the following positions are available to experienced Engineers as follows:

PROJECT ENGINEER

(DESIGN)

For liaison with clients and co-ordination and administration of Specialist design groups working on large scale Oil Refinery and Chemical plant projects. Essential qualifications either A.M.I.Chem.E. or A.M.I.Mech.E.

PROJECT ENGINEER

(CONSTRUCTION)

Will be based in London office but must be prepared to visit sites situated throughout the U.K. Must have a sound knowledge of the planning and overall arrangement of the erection of Oil Refineries, Petrochemical and similar plants.

SALARIES UP TO £2,500 p.a.

Applications, which will be treated in strict confidence, should be addressed to the Managing Director, BOX No. E8763, "The Engineer," giving full details of age, previous experience, &c., and should state which position applied for.

Our own staff have been advised of these vacancies. A

SITUATIONS VACANT

T.I. (GROUP SERVICES) LIMITED

(THE SERVICE COMPANY OF THE TUBE INVESTMENTS GROUP)

A number of vacancies are available in the Plant Development Department of the above company for experienced DESIGN ENGINEERS.

The work of the department includes a wide range of plant design, development of prototype machines, factory planning, progressing installation programmes, etc.

Excellent opportunities exist for promotion.

Applications are invited from men of 28–35 years of age, with experience in the design of special purpose machines and having as a minimum qualification Higher National Certificate or the equivalent. They should be sent, giving full details of qualifications, experience, present salary, etc., to the Personnel Manager, T.I. (Group Services) Limited, Rocky Lane, Aston, Birmingham, 6.

E8703 A

SITUATIONS VACANT

SENIOR DRAUGHTSMEN

experienced in bulk mechanical handling or foundry work. Superannuation Scheme. Five-day week. Apply to MARCO CONVEYOR & ENGINEERING COMPANY Ltd., Lynn Road, Leytonstone, London, E.11. LEY 2254.

E8643 A

SITUATIONS VACANT

INDUSTRIAL LIAISON OFFICER

The Coil Spring Federation Research Organisation requires an Industrial Liaison Officer to strengthen technical relations between the research laboratories and member firms. He will be required to visit member and non-member firms with a view to stimulating their interest and increasing the membership of the Organisation; he will be based in Central England, the actual location to be fixed by mutual arrangement.

The successful applicant will be required to deal with people of the highest levels of industry so that the right personality is a most important quality. A knowledge of the heat treatment or cold work of high tensile materials is desirable. A commencing salary up to £1500 per annum will be paid according to age and experience. Pension scheme.—Applications giving age, education, qualifications and experience to Director of Research, Coil Spring Federation Research Organisation, Doncaster Street, Sheffield, 3. E8764 A

SITUATIONS VACANT

ROOTES GROUP

British Light Steel Pressings Ltd., Warple Way, Acton, W.3. SHE 1230

VACANCIES FOR

TOOL ESTIMATOR

PHYSICAL LAYOUT DRAUGHTSMAN

SENIOR JIG AND FIXTURE DESIGN DRAUGHTSMAN

Good rates of pay and canteen facilities, pension scheme. Social and sports club. Interviewing hours Monday to Friday 8.30 a.m.—5 p.m. Apply Secretary.

E8779 A

THE ASSOCIATED PORTLAND CEMENT MANUFACTURERS LIMITED

require several

SENIOR AND JUNIOR MECHANICAL ENGINEERING DRAUGHTSMEN

for work on plant layout schemes and details at Head Office, Westminster.

Experience in heavy machinery plant layout and mechanical handling an advantage. Applicants with H.N.C. in Mechanical Engineering preferred for Senior Posts.

The Company offers good salaries and working conditions, pension fund and profit-sharing bonus.

Replies, giving particulars of training and experience, will be treated in full confidence and should be sent to the following, marked "Personal":—

The Manager,
Central Engineering Department,
Associated Portland Cement Manufacturers Ltd.,
Portland House, Tothill Street, LONDON, S.W.1.

E8664 A

VICKERS-ARMSTRONGS (ENGINEERS) LTD. require

TECHNICAL ENGINEERS

at their Southampton Office

for design calculations in connection with the Dounreay Nuclear Submarine Prototype.

Applicants should hold a University Degree or H.N.C. in Mechanical Engineering. Candidates with Marine Engineering experience (seagoing or construction) are preferred.

In addition to the above,

ARRANGEMENT AND DETAIL DRAUGHTSMEN

are also required.

Salary will be in accordance with age, qualifications and experience.

Applications should be in writing to:

The Manager,
VICKERS-ARMSTRONGS (ENGINEERS) LTD.,
Oak Yard, Hazel Road, Itchen, Southampton.

E8725 A

A leading contracting Company engaged on the design of large Oil Refineries and Chemical Plants is seeking the services of a

PROJECT ENGINEER

who will be responsible for the co-ordination of specialist design groups and liaison with clients.

Applicants, aged about 40, should already be in a similar position and hold either A.M.I.Mech.E. or A.M.I.Chem.E.

Commencing salary up to £2000 p.a.

with excellent prospects.

Please write, giving full details in confidence, to BOX No. E8645, "The Engineer."

A

MECHANICAL EQUIPMENT ENGINEER

required by leading contractors to the Chemical and Petroleum Industry.

Applicants should have first-class experience of Pumps, Compressors and Reciprocating Machinery of all types and be of A.M.I.Mech.E. standard.

SALARY IN THE REGION OF
£1,750 P.A.

Applications, which will be treated in strict confidence, should give full details of age and experience &c., to BOX No. E8722, "The Engineer."

A

ENGINEERS, DESIGNERS, STRESSMEN

AIRCRAFT — NUCLEAR — MECHANICAL HANDLING — MINING — RAILWAY — MARINE — SPECIALISED MACHINE TOOLS — SERVOS

ELECTRO-HYDRAULICS LIMITED

Require men with
Initiative Creative Ideas Sound Common Sense
as

Project Engineers
Designers
Draughtsmen
Laboratory Engineers
Stressmen
Trainees

for interesting design and development work on new products in their mechanical engineering and hydraulic control laboratories.

The following qualifications are taken into account :—

University Degrees
H.N.C.
G.C.E. Advanced Level
Recognised Apprenticeship
Experience in similar work

Generous salaries will be paid commensurate with qualifications and experience. A contributory pension scheme is operated.

Sales Engineer

A technical representative is required for selling solenoid valves and associated hydraulic equipment. He must have experience of selling this type of product in the London area where he should be resident already.

Application forms from :—
The Technical Director,
Electro-Hydraulics Limited,
Liverpool Road, WARRINGTON.
MEMBER OF THE OWEN ORGANISATION E8760 A

Classified Advts. continued on page 116

SITUATIONS VACANT

LAING

MECHANICAL DESIGN ENGINEERS

The following vacancies exist in the Laing group of Companies. The work is of an interesting nature and concerned with the development of new machines and processes connected with the Building and Civil Engineering Industries.

SENIOR DESIGNER

required with experience in factory layout and factory machinery, for THERMALITE YTONG LIMITED. The work will involve the development of equipment for the production of high-class building components. A.M.I.Mech.E. qualifications, with experience in Mechanical Handling, required.

SENIOR DESIGNERS

for the Research and Development Centre of John Laing and Son Limited at Boreham Wood. Applicants should be of A.I.M. Mech.E. standard and have experience in the development of new and improved types of CONTRACTORS' PLANT.

ASSISTANTS

to the above are required of H.N.C. or Graduate level, some experience required.

GRADUATE MECHANICAL & CIVIL ENGINEERS

with Site experience in the operation of contractors Plant, for work involving the study, performance and development of the mechanisation techniques applied within the Contracting Industries.

All these posts are permanent and progressive. Pension Scheme.

Applicants should write in the first instance to —

Personnel Manager (Ref. M.D.E.1)
John Laing and Son (Holdings) Limited,
Page Street, N.W.7.

E8738 A

SITUATIONS VACANT

TECHNICAL MANAGER

required for old-established and progressive engineering firm of medium size known the world over.

Products cover high-quality medium-heavy to light mechanical and hydraulic machinery in small batches for a great variety of industrial applications both in production and research.

An intensive development programme is followed which must be maintained and augmented with suitable instrumentation of mechanical, electrical and electronic kinds.

Qualifications include thorough technical knowledge and practical experience of engineering, and ability both to control design staff and to foster the whole of the Firm's technical activities from a broad and progressive angle.

Fullest particulars should be given of academic qualifications, practical experience, posts held, type of work handled, and of contacts with industry and research establishments.

Write, stating age, present earnings and when available, to :

The Managing Director,
SAML. DENISON & SON, LIMITED,
HUNSLET FOUNDRY,
LEEDS, 10. E8568 A

SITUATIONS VACANT

BRITISH RAILWAYS RESEARCH DEPARTMENT, ENGINEERING DIVISION, DERBY

Vacancy for

Scientific Officer Grade 2.

Initially to study problems connected with dynamics of trains shocks to goods in transit, etc. Candidates should have good degree. Previous experience of research not essential. Salary range: £665 to £985 p.a. (commencing salary according to qualifications and/or experience). Superannuation and certain travel facilities.

Medical examination.

Applications stating age, experience, etc., to :–

Director of Research
(British Railways),
British Transport Commission,
222 Marylebone Road,
LONDON, N.W.1.

E8714 A

SITUATIONS VACANT

A.E.R.E.
HARWELL

EXTRA MURAL RESEARCH

A vacancy exists in the INDUSTRIAL COLLABORATION OFFICE for a SCIENTIST or PROFESSIONAL ENGINEER to initiate, in collaboration with A.E.R.E. Research Divisions, contracts for research and development, particularly within the field of materials and components, for reactor systems. The contracts will be with universities, industrial firms, research associations and Government departments.

Experience in handling research and development contract problems would be an advantage.

Applicants for the scientist appointment should have an Honours Degree in Physics or Engineering and an Honours Degree in Engineering would be an advantage for the professional engineer.

Salary : £1535–£2180 p.a., according to qualifications and experience.

Housing and superannuation schemes.

Please send POST CARD for details to Group Recruitment Officer (1517/25), U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks.

E8720 A

Junior Plant Engineers
Metallurgists
Chemists and Physicists

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PRODUCTION GROUP REQUIRE

JUNIOR PLANT ENGINEERS, METALLURGISTS, CHEMISTS, AND PHYSICISTS AT

CAPENHURST WORKS, CHESTER
CHAPELCROSS WORKS, ANNAN, DUMFRIESSHIRE
SPRINGFIELDS WORKS, SALWICK, PRESTON, LANCS., AND
WINDSCALE & CALDER WORKS, SEASCALE, CUMBERLAND

The Group is responsible for the operation of reactor stations at Calder and Chapelcross, the prototype Advanced Gas Cooled Reactor and chemical processing plants at Windscale, the fuel element production plants at Springfields and the gaseous diffusion plant at Capenhurst. The Works processes are controlled by Engineers and Scientists with a background of industrial experience. The work includes production control, labour management, critical examination of costs in relation to chemical and physical plant operation. In each Works there is a large Engineering Branch responsible for plant and instrument maintenance and workshop organisation.

These appointments are in an introductory grade with duties designed to give varied experience in aspects of works operation with a view to promotion to managerial status and possible advancement to more senior staff.

Engineers are required to have an Honours Degree in Engineering, with approved apprenticeship or experience, a diploma of technology, or Graduate Membership of a Senior Engineering Institution. Consideration will be given to candidates who are nearing completion of qualifications for graduateship.

Chemists and Physicists must have an Honours Degree in Chemistry, Physics Metallurgy, Engineering or Chemical Engineering, or equivalent.

Commencing salary according to age within scale — £595 (at age 20) to £1,025

Contributory Superannuation. · Staff Housing Scheme.

Send postcard to the Works Secretary at the location of your first preference quoting reference P.126/J1.

E8718 A

SITUATIONS VACANT

ANOTHER OPPORTUNITY
IN
IRON AND STEEL

BISRA

ENGINEERS AND PHYSICISTS

are required by the Plant Engineering and Energy Division for research on Steelworks Plant.

The positions to be filled provide interesting and varied work, and call for a capacity for original thought coupled with enthusiasm and drive to encourage the application of research results in iron and steel works.

Candidates should be Graduates or Corporate Members of an appropriate Institution. Experience in the steel industry is not essential, but some experience in a heavy engineering industry is an additional advantage.

The Division's headquarters are at the London Laboratories in Battersea, but the research staff make frequent visits to works and the Association's other Laboratories.

Applications are invited for the following positions :—

(1) An Electrical Engineer to lead a team working on problems of automatic control of heavy electrically or hydraulically driven plant. The applicant should have a good knowledge of servomechanism theory and some experience of using harmonic response equipment or analogue simulators. Experience with heavy electrical plant is preferred. Starting salary in the range £1075 to £1425 or higher for a particularly suitable candidate. (Quote reference "E.E.2.")

(2) An Electrical Engineer for work on automatic control of heavy plant. An interest in servomechanisms and some experience in this field is essential. Starting salary up to £1000. (Quote reference "E.E.3.")

(3) Two research workers for the investigation of problems connected with the use of energy in steelworks processes. Qualifications in mechanical or chemical engineering would be suitable, or qualifications in physics or electrical engineering with an interest in heating problems. Experience in any of the following would be an advantage : fluidised beds, induction heating, temperature measurement, heat transfer mechanisms, combustion processes, or thermal properties of materials. Starting salary up to £1050, but one post might qualify for a higher salary for a particularly suitable candidate. (Quote reference "E.N.4.")

(4) A Civil or Mechanical Engineer with experience in stress measurement or steel structures, to work on the recording of stresses in cranes and steelworks buildings with a view to improved design methods. Starting salary up to £1050. (Quote reference "E.17.")

Applications should be made in writing, quoting the appropriate reference number, to the Personnel Officer, The British Iron and Steel Research Association, 11, Park Lane, London, W.1.

E8778 A

BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION

Applications are invited for appointments to the DEVELOPMENT STAFF and to the BRIDGE DEPARTMENT.

Candidates should be young men with some experience in the design and detailing of steel frame buildings with knowledge of B.S.449 or with experience in the design of steel bridges with knowledge of B.S.153. Five-day week and luncheon vouchers. Admission to non-contributory pension scheme after qualifying period.

Apply in confidence to the Technical Adviser, British Constructional Steelwork Association, Artillery House, Artillery Row, London, S.W.1, giving fullest details with salary required.

E8675 A

SITUATIONS VACANT

BUILDING SURVEYOR/ESTIMATOR

required by

W. H. ALLEN SONS & CO., LTD., BEDFORD

The successful applicant will be responsible to the Works Engineer for the introduction and, later, operation and financial administration of a Progressive Building Maintenance Scheme.

Age should be between 25–35 years and qualifications should include, for preference, A.R.I.C.S.

The Company has an excellent Pension and Life Assurance Scheme in operation and offers good working conditions and welfare amenities. Assistance will be given towards moving expenses.

Applications, in writing, stating details of past experience and present salary, should be forwarded to the

PERSONNEL MANAGER,

(quoting reference No. 1602/C9).

E8734 A

SITUATIONS VACANT

A client in the London area manufacturing and marketing a wide range of products based mainly on oils, resins, rosins, bitumens, pitches, rubbers and polymers, requires :

A WORKS MANAGER

who would be answerable to the Works Director and must be able to act for him in his absence. Must be a man of very strong character, good on human relations, and with technical background. A qualification in industrial management or from a technical institute would be valuable but not essential.

Age range 33–40. Six months on probation at £1500 ; thereafter not less than £2000.

Apply in confidence, quoting reference A/M, to :

THE P.E. GROUP,
12, Grosvenor Place,
London, S.W.1.

E2701 A

SITUATIONS VACANT

Leading Midland Machine Tool Company have a vacancy for a

SALESMAN

to specialise in the sale of high grade heavy machine tools. Good engineering training essential. Knowledge of steel industry an asset. Responsibilities include travelling the whole of the country and occasionally abroad. A car will be provided and there is an attractive pension scheme. Good basic salary and commission.—Applications, giving full details of past experience together with age and salary expected to BOX No. E8736, " The Engineer."

A

SITUATIONS VACANT

BRITISH OXYGEN GASES, LTD.

ELECTRICAL ENGINEER

An Electrical Engineer between 25 and 30 years of age is required for interesting development work in connection with power units and control gear for inert gas welding. A knowledge of electronics is an advantage, and the candidate should possess a degree or H.N.C. in electrical engineering.

TECHNICAL ASSISTANTS

Technical Assistants are also required in the age range 25-30. They should have an electrical background and a H.N.C. in electrical engineering would be preferred. Candidates should have a knowledge of electronics or development experience in industry.

There are good future prospects and very good commencing salaries are offered.

Please reply stating full particulars to

THE PERSONNEL MANAGER,
SPENCER HOUSE,
ST. JAMES'S PLACE,
LONDON, S.W.1.

E8731 A

a number of DESIGN ENGINEERS

are required, with experience in the design and the associated calculations of Condensing, Feed Heating and De-aerating Plants for Land service Power Stations.

Applicants should have a University Degree or equivalent qualification, with specialised experience in Heat Transfer.

Salaries offered will be appropriate to experience and responsibility, and there is a contributory Pension and Life Assurance Scheme in operation.

Barrow in Furness is pleasantly situated on the coast adjacent to the Lake District. The Company has a well-appointed Sports Club and Grounds, with comprehensive recreational facilities, both social and sporting. An illustrated guide to the town and surroundings can be sent on request.

All applications should be addressed to the

ENGINEERING TECHNICAL MANAGER,
VICKERS-ARMSTRONGS (ENGINEERS), LIMITED,
Naval Construction Works, Barrow in Furness, Lancashire.

E8654 A

PRESSURE VESSEL DESIGNER

This position requires knowledge of the British and American Codes and experience in design of pressure vessels such as refinery fractionating towers and/or boiler steam drums and Higher National Certificate with knowledge of strength of materials, welding, etc., and experience in a fabricator's shop or design office on such items will all be advantageous, but ability and experience in any other similar lines will be useful and will be given full consideration.

This position is permanent and offers a well-paid career with scope for advancement in a Company whose reputation is well known in the Petroleum and Petro-Chemical industries, supported by good working conditions, yearly salary review, generous sickness benefits, free luncheon vouchers, contributory pension scheme, free life insurance benefits, generous overtime payments and five-day week.

Please write, giving details of experience and qualifications, to Personnel Manager :

KELLOGG INTERNATIONAL CORPORATION

7-10 CHANDOS STREET, CAVENDISH SQUARE, LONDON, W.1. *quoting reference 154/G*

E8716 A

DESIGN ENGINEER

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE.

To be responsible for design and development of a wide range of light mechanical equipment with a bias towards precision instrumentation.

Applicants should be Corporate Members of the Institution of Mechanical Engineers or have equivalent qualifications. They should have had several years' design office experience. A sound knowledge of elementary physics would be an advantage.

SALARY :
Within the range £860–£1825, according to age, qualifications and experience.

Contributory Superannuation Scheme. A house, or substantial assistance with house purchase, will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref. 2533/25.

E8739 A

POWER RECTIFIER DESIGN

Due to expanding business, a large electrical manufacturing firm in the Midlands requires ASSISTANT DESIGN ENGINEERS for rectifier work. Previous rectifier experience not necessary but applicants should have degree (electrical) or equivalent, and some practical training. Work involves mercury arc and semiconductor rectifiers and application engineering of all kinds, with scope for wide experience and interest ; good salary and prospects. Pleasant residential area ; ample housing ; educational facilities excellent.

Apply with full particulars.—BOX No. E8509, " The Engineer."

A

IMPERIAL SMELTING

U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

The following engineering vacancies are currently available at the Avonmouth Works and in Group Departments on the Avonmouth Site :

AVONMOUTH WORKS

Assistant Area Engineer
Duties involve controlling work done by tradesmen and labourers on zinc blast furnace and associated plant, including provision of spares, operation of bonus schemes, and general supervision of engineering maintenance work. An apprenticeship, preferably in heavy engineering, and professional qualification or degree in Mechanical Engineering essential. Previous experience in a supervisory capacity in heavy chemical or metallurgical industry is desirable. Age limits 23-35. Ref. TE/ENG/70

CHIEF ENGINEER

Engineering Assistants
Opportunities to train for future engineering posts of responsibility exist for two young men with a university degree or Higher National Certificate in Mechanical or Chemical Engineering. Mobility is important since the persons appointed may be required to work for indefinite periods at any of the seven Works Sites. Ref. TE/ENG/71

Group Mechanical Engineer
One of a team of design engineers who are collectively responsible for the detail design work arising out of capital expenditure projects at any of the Corporation's Works and for following the projects through to their completion, including procurement and construction. A university degree or professional qualifications in Mechanical Engineering will be required, together with sound design experience—preferably in heavy engineering. Ref. TE/ENG/72

Draughtsmen
For the development of schemes and detailing of equipment to guide invitations to tender and the manufacture of plant. At least five years' experience—preferably in heavy engineering—is required and preference will be given to candidates holding N.C. or H.N.C. in Mechanical Engineering. Ref. TE/ENG/73

IMPERIAL SMELTING PROCESSES LIMITED

Design Engineer
A qualified engineer, preferably with a first class honours degree and sound experience, including design in the heavier type of engineering, is sought. Duties are to participate in the design and development of blast furnaces and ancillary plant for the Imperial Smelting Process, and in this instance, fluency in both written and spoken German is very desirable. Ref. TE/ENG/74

Applications, quoting the reference(s) of particular interest and giving brief details of qualifications and experience should be addressed to :

Personnel Manager,
IMPERIAL SMELTING CORPORATION LIMITED,
St. Andrew's Road, Avonmouth, Bristol.

E8650 A

Classified Advts. continued on page 118

SITUATIONS VACANT

THE CALTEX ORGANISATION
require
AN ELECTRICAL ENGINEER
for service both in London and overseas to perform electrical design work for oil refineries and associated facilities.
General requirements are :
(*a*) Degree in Electrical Engineering.
(*b*) Postgraduate apprenticeship with a large electrical industrial organisation.
(*c*) A.M.I.E.E.
Candidates should also have had approximately four years' experience as a Design Engineer responsible for the electrical aspects of power generation, distribution and industrial utilisation on systems up to and including 11kV.
Preferred age group 28–32 years. Commencing salary would be dependent upon qualifications and experience. For Foreign Service additional living allowances are paid and free medical attention, air-conditioned accommodation provided, plus an initial kit allowance and attractive Vacation and Benefit Plans.
Apply in writing quoting "ETS" with full particulars of qualifications and experience to Caltex Services Limited, Caltex House, Knightsbridge Green, London S.W.1.
E8790 A

K & L STEELFOUNDERS AND ENGINEERS LIMITED
Member of the 600 Group
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CHARTERED MECHANICAL AND ELECTRICAL, energetic 55, interested in U.K. post where wide experience home and overseas can be used. Willing travel occasionally. Minimum £2000.—BOX No. E2711, "The Engineer." B

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DIRECTORSHIPS, salary and share profits of growing light Eng. Co. (Ltd.), South Coast with valuable contacts, offered to one or two working Engineers, by retiring Director. Total required, about £6/£7000 for expansion.—BOX No. E2702, "The Engineer." O

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Swansea . Newcastle . Belfast . Sheffield
Southampton . Bath
E200 K

PATENTS

THE PROPRIETOR of British Patent No. 762447, entitled "A TUBE COUPLING," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A. E8659 H

PATENT NO. 744641.—"IMPROVEMENTS IN PACKINGS FOR PISTONS, PLUNGERS OR PISTON RODS IN CYLINDERS OF HYDRAULICALLY OPERATED DEVICES." The Proprietors of Patent No. 744641 desire to enter into arrangements by way of licence or otherwise on reasonable terms to ensure its full development and commercial working in this country.—Address enquiries to : W. P. Thompson & Co., Chartered Patent & Trade Mark Agents, 12, Church Street, Liverpool, 1. E8775 H

THE PROPRIETOR of British Patent No. 799,679 entitled "IMPROVEMENTS IN OR RELATING TO WATER HEATERS" offers same for sale. The designs are of an oil-burning water heater. Also available, alternative hearths permitting a range of products and choice of fuels with same boiler unit.—Inquiries to Hedges & Son, The Market Place, Wallingford, Berkshire. E2706 H

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E170 G

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RHODES No. 21 size, Inclinable Power Press, motorised for 420/3/50, pressure exerted 30 ton, stroke 3½in., bed 28in. by 18½in., hole in bed 16in. by 12in., with automatic safety guard, weight approximately 47 cwt.
QUICKWORK No. 321, Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity mild steel 14 S.W.G., cuts circles from 6in. to 60in. diameter, hand feed control lever enables operator to cut intricate shapes by hand, weight approximately 18 cwt.
NEW BROOM & WADE Motor-Driven Air Compressor Unit, comprising type NK vertical single cylinder air cooled compressor fitted with inlet air filter and air governor, capacity 3 c.f.m. delivered at 100 lb. p.s.i. pressure, motorised for 380/420/3/50 cycles supply.
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200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
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OVERHEAD CRANES.—20/6-ton Vaughan 42ft. 3in. span, cab type (6) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 15-ton Booth, 37ft. span, 400/3/50; 15-ton Morris, 35ft. span, hand-operated ; 10-ton Morris, 48ft. span, 36ft. lift ; 10-ton Vaughan, 23ft. 6in. span, 400/3/50 ; 10-ton Vaughan, 21ft. span, 44ft. lift ; Wharton 7½-ton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand-operated ; 5-ton Royce, 2-motor crab, 440/3/50 ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V., d.c. (3) ; 3-ton Adamson, 48ft. span, 400/3/50 ; 2-ton Adamson, 34ft. span, 400/3/50 (2) ; 2-ton Morris, 18ft. span ; 2-ton Vaughan, 27ft. 6in. span, 2-motor ; majority of the above are unused.
DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric ; 7-ton Rushworth, hand, 30ft. jib ; 5-ton Wilson, electric, 70ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib.
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LOCOS.—Fowler diesel, 150 h.p. (2) ; Barclay & Ruston 80/88 h.p. diesel ; Bagnall 14in. by 22in. (two oil-fired, one coal), Peckett, steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.
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2000kW Metropolitan-Vickers TURBO-ALTERNATOR SET, pass out Turbine 250 lbs. pressure, pass-out 30 lbs., coupled through reduction gearbox to Alternator, 440 volts, 3-phase, 50 cycles, 1000 r.p.m., condensing plant and control gear.

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Battery of TWO Brick set ECONOMIC BOILERS by Daniel Adamson, 10ft. diameter by 15ft. 6in. long, with Hodgkinson Mechanical Stokers, Green's Economiser of 480 tubes, I.D. Fan, Superheaters and 3 Weir Pumps, Working pressure 265 lbs. per square inch ; superheated 560/640 deg. Fah., total capacity 25,000 lbs. per hour.

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		Main Location	*Auctioneers*
February 10	Machine tools and miscellaneous stores, including :—	Technical Stores Depot, Old Dalby, Leics. (Sale at Melton Mowbray.)	SHOULER & SON (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
	Lathes, boring and surfacing, centre, turret and precision ; milling and nibbling machines ; shapers ; pillar bench and portable electric drills ; grinders and sanders ; presses ; gear generating machine ; fuel pump grinding and lapping machines ; wet grinders ; cylinder borers ; forges and hearths ; electric drying ovens ; watchmaker and instrument lathes ; arc welders and transformers ; welding kits and spares ; engraving machine ; universal woodworkers ; planers and thicknessers ; plane and mould iron grinders ; chain and chisel mortisers ; bench portable, chain and electric saws ; lathe turning tools ; saw blades ; spluttering machines ; test instruments ; voltmeters ; photographic and cine spares, etc.		
February 18	Miscellaneous stores.	M.O.A. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
February 25	Vehicles and miscellaneous stores.	M.O.A. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE, LTD. (Dept. L), Bank Buildings, Graham Street, Glasgow E.1. (Tel.: Bridgeton 2447/9.)
March 1-2	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Manchester, 8.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
March 8	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
March 15	Miscellaneous stores.	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
March 15-18	Vehicles, earth moving and lifting equipment.	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)

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E118 J

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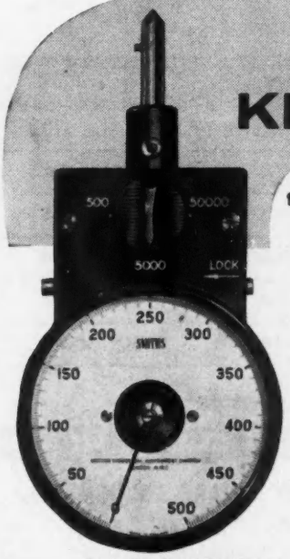

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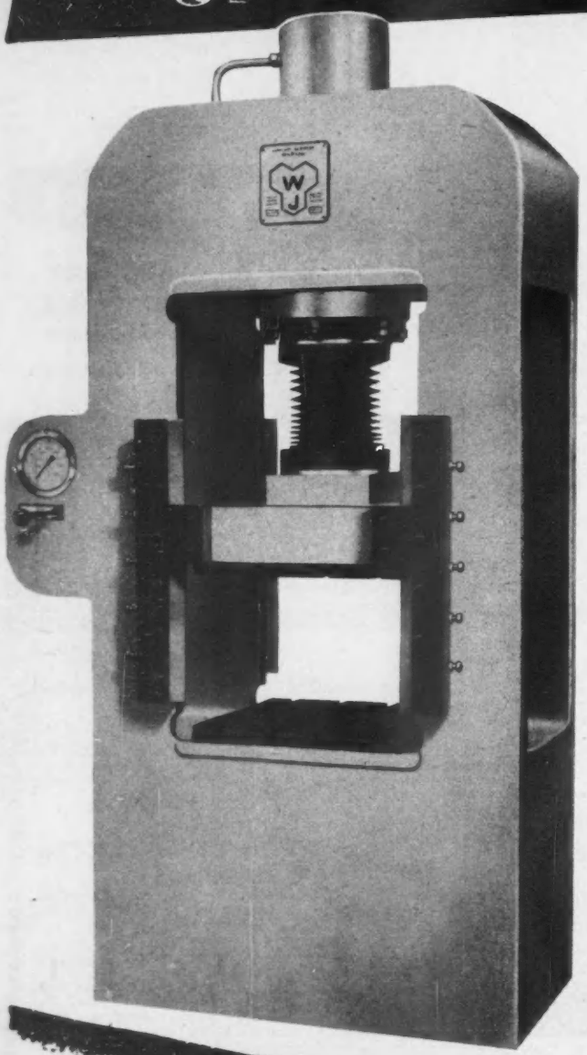

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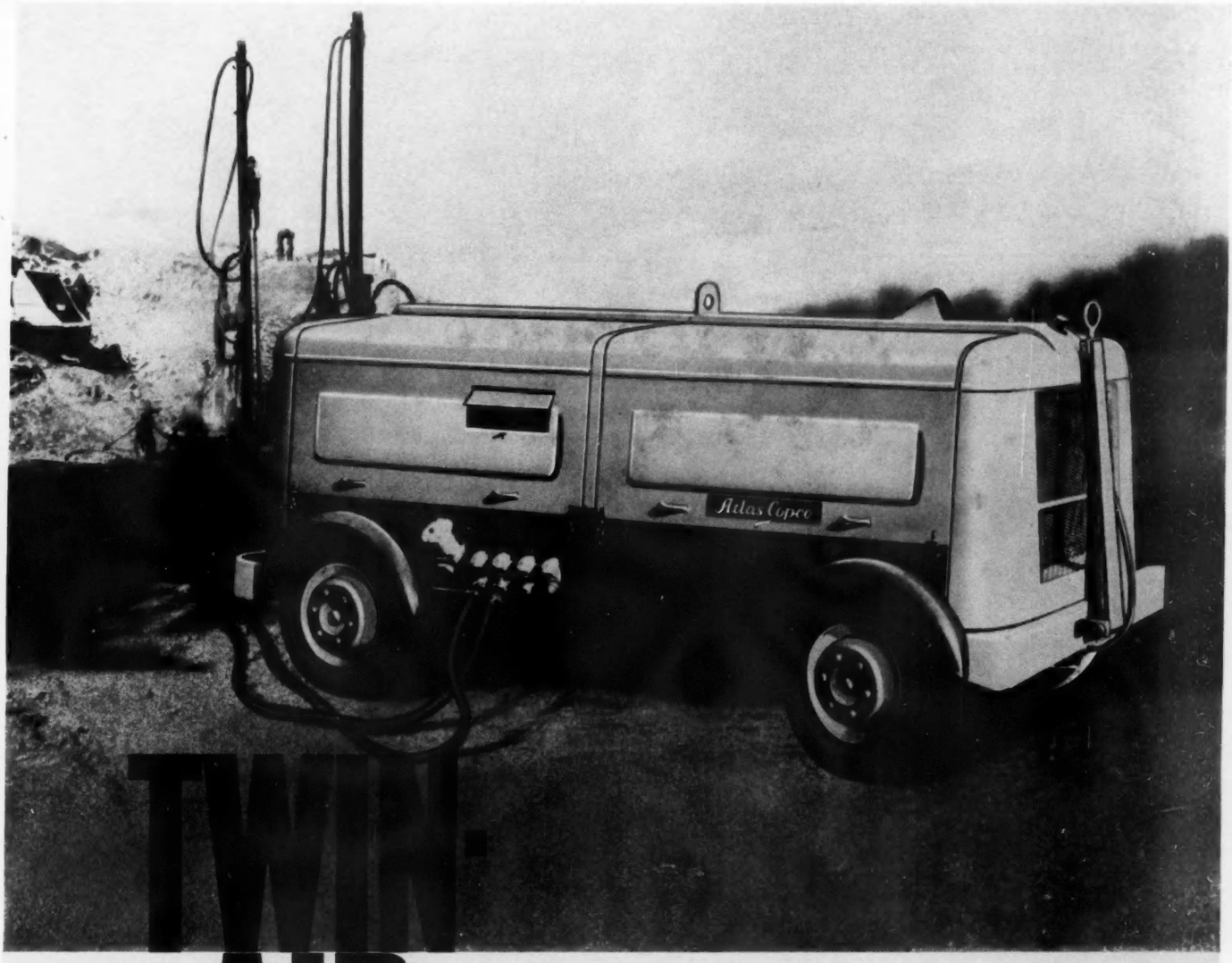

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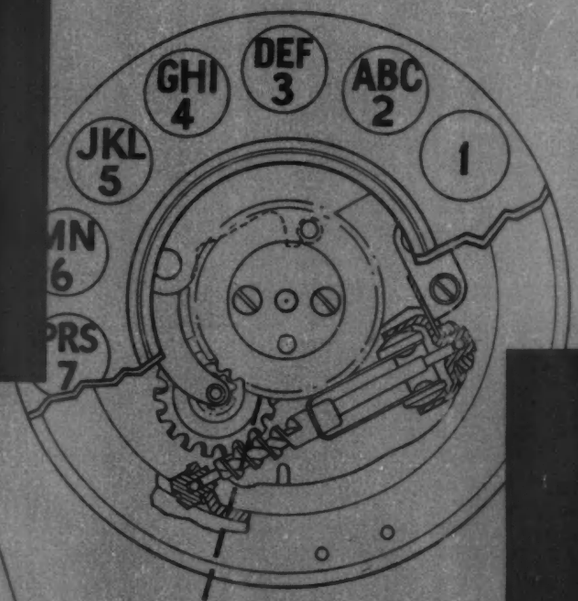

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